The Journal of the Parliamentary and Scientific Committee – A Prospective All-Party Parliamentary Group

SCIENCE IN PARLIAMENT
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AUTUMN 2019

The Physiological Society

Growing Older, Better launch

Growing Older, Better

We need a step change in response to meet the healthy ageing challenge

A girl born in the UK today has a 1 in 3 chance of living to 100. However, there has been too little focus on healthy ageing and people are living more years in poor health. Those born today are forecast to spend up to a quarter of their lives in poor health.

The vital role of physiology

The UK Government has a target of ensuring people can enjoy at least five extra healthy independent years of life by 2035. Physiology is at the heart of understanding ageing, its causes and how best to maintain quality of life for as long as possible. Physiology is therefore crucial to tackling the healthy ageing challenge.

The cutting edge research being undertaken by physiologists is advancing our knowledge and helping us live healthier for longer.

Growing Older, Better launch

Our *Growing Older, Better* project brought together experts from across the health, research and public policy sectors to consider how the Government can meet its healthy ageing target. The Physiological Society is concerned that the Government risks not meeting its target and our recommendations urge a step change in activity.

We were delighted to welcome over 80 politicians, policymakers and researchers to the launch in Parliament. Hosted by Stephen Metcalfe MP, the panel debate heard from a range of voices on the healthy ageing challenge.

An ambitious target for healthy ageing requires an ambitious response, and we believe that this can only be achieved by placing physiology at its heart.

About The Physiological Society

The Physiological Society is the largest network of physiologists in Europe. We support physiologists by organising world-class conferences and offering grants for research. We publish the latest developments in the field in our leading scientific journals.

To find out more and read the report, visit www.physoc.org/healthyageing

Stephen Metcalfe MP
Prospective Chairman,
Parliamentary & Scientific Committee (A prospective All-Party Parliamentary Group)

A warm welcome to the Autumn 2019 edition of Science in Parliament.

Since the publication of the Summer issue The Parliamentary and Scientific Committee held three well-attended discussion meetings entitled 'STEM and Diversity', 'AI and Health' and 'Climate Change – is there a Plan B?'

For STEM and Diversity, in July, our guest speakers were: Dr Hilary Leevers, Chief Executive, Engineering UK; Andrew Croydon, Skills & Education Policy Director, Association of the British Pharmaceutical Industry; Paul Jackson, Executive Director of Jasia Education Ltd; and Professor Josie Fraser, Deputy Vice Chancellor (Acting), The Open University.

Articles from the speakers appear in this edition, along with those contributing to preceding discussion meetings on 'Throwaway Waste and Disposable Fashion' and 'Fake News'.

We also have excellent contributions from, Dr Charlotte Adams, William Dance, Nick Hyett and Daniel Pomarede and Chris Reed.

For 'AI and Health', in September, held in partnership with the All-Party Parliamentary Group on Artificial Intelligence (APPG AI), presentations were delivered by Professor Birgitte Andersen, CEO and CoCreator, Big Innovation Centre, Professor Roma Maguire, Professor of Digital Health and Care, University of Strathclyde, Dr Ali Parsi, CEO of Babylon Health, and Dr Navin Ramachandran, Healthcare Specialist in distributed ledger and IoT, IOTA Foundation.

In October, our speakers on 'Climate Change' were: Dr Hugh Hunt, Reader in Engineering Dynamics and Vibration, University of Cambridge; Professor Chris Rapley CBE, Professor of Climate Science, UCL; and Professor Sir David King, Emeritus Professor of Physical Sciences, University of Cambridge, and former UK Chief Scientific Adviser.

Our speakers from the September and October meetings have kindly agreed to contribute to the next edition of Science in Parliament.

In a number of recent speeches, the Prime Minister has praised UK leadership in science and has said that Britain has the capability of becoming carbon neutral by the middle of the century.

We welcome his recent announcement, at the United Nations, to provide, scientists with up to £1 billion to develop technology that will tackle climate change, through the clean energy fund named in honour of British physicist and Suffragette, Hertha Ayrton.

Finally, I should like to welcome Lord Broers who, I am delighted to say, was elected as our President, at the Annual General Meeting on 14th October. A pioneer in nanotechnology, Alec Broers is one of our most distinguished scientists and is a former Vice-Chancellor of the University of Cambridge and former President of the Royal Academy of Engineering.

He succeeds Lord Oxburgh who has stepped down after many years as our President. We thank Ron for his wonderful service to, and support for, the Committee, and wish him well for the future.

SCIENCE IN PARLIAMENT
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The Journal of the Parliamentary and Scientific Committee (A prospective All-Party Parliamentary Group).

Science in Parliament has two main objectives:

1. to inform the scientific and industrial communities of activities within Parliament of a scientific nature and of the progress of relevant legislation;
2. to keep Members of Parliament abreast of scientific affairs.

EDITORIAL NOTE

Members will receive this Autumn issue of Science in Parliament, some weeks after it was scheduled to be distributed.

This was due to the Dissolution of Parliament on the 6th November 2019, which meant that the Parliamentary & Scientific Committee ceased to exist.

For a period after the General Election, the Committee will be termed 'A prospective All-Party Parliamentary Group' until it is registered as a full APPG, following the election of Officers on Monday 13th January 2020.

Leigh Jeffes, Editor

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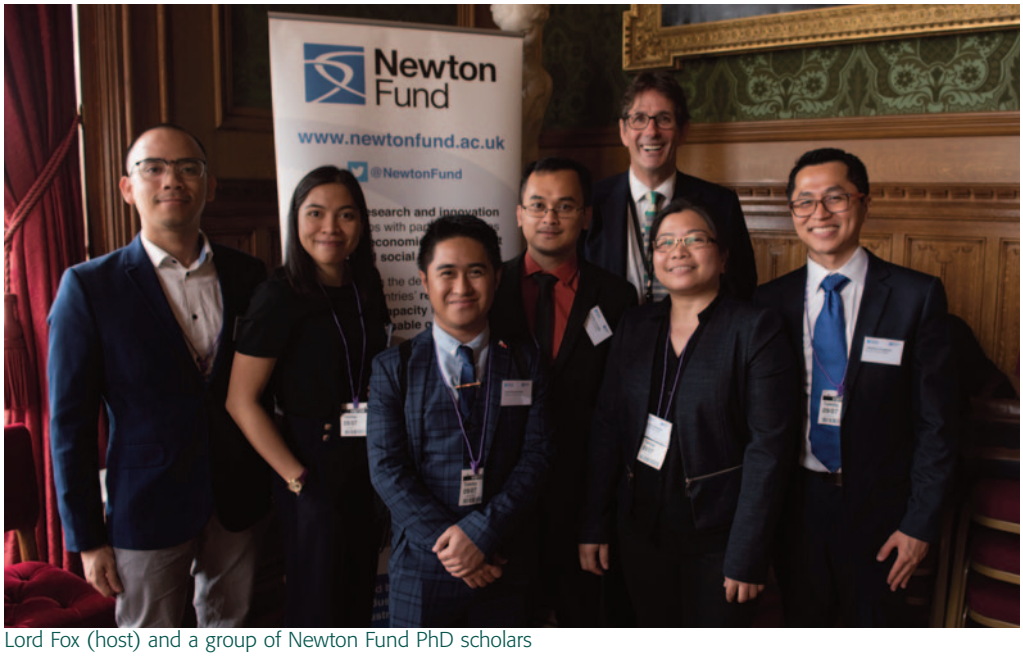
The Journal of the Parliamentary and Scientific Committee (A prospective All-Party Parliamentary Group).

2019 BRITISH COUNCIL SCIENCE AND POLICY MAKING SYMPOSIUM

In July, the British Council and Lord Fox, Member of the House of Lords Science and Technology Committee, hosted a science and policy making symposium in Parliament for early career researchers from around the world. The participating PhD scholars from Colombia, Egypt, Philippines, South Africa, Turkey, Vietnam, China, India, and Thailand are supported by a Newton Fund grant and are studying at UK host universities. The Newton Fund is part of the UK's official development assistance and builds research and innovation partnerships with 17 partner countries worldwide to support economic development and social welfare.[1] The Fund is managed by the UK's Department for Business, Energy and Industrial Strategy (BEIS) and delivered by the British Council[2] and six other UK delivery partners[3].



Lord Fox (host) and a group of Newton Fund PhD scholars

The Newton Fund PhD programme facilitates capacity building and skills development of early career researchers and helps to create sustainable, long-lasting links between the UK and partner countries. More than 500 PhD students have been supported so far. The students work on solutions to developmental challenges such as infectious diseases, renewable energy, sustainable agriculture, climate change and food security. One of the scholars who attended the symposium is Poonam Panchal, a molecular biologist from India, who is currently studying at the John Innes Centre in Norwich. Her research explores new ways of increasing the crop productivity of rice to help with the challenges of a growing population. She said thanks to the Newton Fund she was able to conduct experiments that would have not been possible in her home country.

At the event, Poona and other participants had the opportunity to learn about UK Government and Parliament. The symposium took place in the River Room in the House of Lords and saw several keynote speeches and panel discussions with invited speakers from Parliament and the UK's science policy and public engagement community. During a lunch reception, the students discussed their research with MPs, peers and senior experts and network with other invited guests.

One of the first talks was given by Dr Grant Hill-Cawthorne, Head of Parliament Office of Science (POST). He explained the science policymaking process in the UK and provided practical tips and advice for researchers on how best to engage with Parliamentarians. In the following session, Professor Chris Whitty, Chief Scientific Adviser for the Department of Health and Social Care, told the students about the responsibilities of a UK Chief Scientific Advisor and described the challenges and opportunities in his role as a "knowledge broker" between the scientific community and UK Government.

The first panel, chaired by Lord Fox, looked at controversial issues in science and involved Lord Hunt of Chesterton and Baroness Morgan, both members of the House of Lords Science and Technology Committee. The panel highlighted several priority areas for science policy making such as climate change, big data, modern medicine and the use of genomics. Lord Hunt of Chesterton emphasized the need to strengthen researcher's communication skills and the ability to explain complex scientific problems to the public. Lord Fox said that both scientists


Newton Fund scholars

and policy makers must adopt a language that is "inclusive" in order to reach sensible conclusions. Panelists discussed the example of the public debate on gene editing and STEM cell research.

As part of the event, James Cronin, Trustee of the British Council, and Lord Fox each gave keynote speeches. James Cronin highlighted the British Council's long-standing commitment to build research collaborations worldwide to help create strong relationships between the UK and partner countries. He compared science to the field of language learning which is another central British Council area of work. He said "science is an international language: a lingua franca that connects people regardless of nationality or political affiliation. Its purpose is to discover fundamental truths and expand the field of knowledge – for the benefit of everyone." [4]

Lord Fox noted the need for scientific research and evidence-based policy making in an age defined by populism and the "primacy of opinion over fact". He highlighted the example of the anti-vaccine movement. "We have to stand up for science and for scientific ideas" he said, and encouraged Newton Fund scholars to help shape the future through their work.

Stephen Metcalfe MP, James Cronin, Chi Onwurah MP, Helen Jones, and Martin Smith

The topic of language and communication was picked up again in the second panel which included the panelists Chi Onwurah MP, Shadow Minister, Industrial Strategy, Stephen Metcalfe MP, Member of the Science and Technology Committee, Martin Smith, Policy Manager, Wellcome Trust, and Helen Jones, Director of Strategy and International, Science Museum. Chi Onwurah MP spoke about building "trust" through effective engagement and communication. She said it is important "for people to trust scientists, and scientists need to trust people". Helen Jones from the Science Museum described the need for science to become part of society and "to stop the cultural divide" and break down barriers between disciplines and countries. Stephen Metcalfe MP encouraged the Newton Fund scholars to engage with Parliamentarians and to contribute though submissions to broaden the evidence base.

The panel also discussed issues and barriers in the visa and immigration system. Considering the debate on Brexit, all panellists agreed that there is a greater need than ever to strengthen international scientific collaboration across borders. At the end of the event, Newton Fund scholars had the opportunity to join a tour of the Houses of Parliament.

Chi Onwurha, MP, took part in a "Question time" style discussion

Dr Grant Hill-Cawthorne, Head of Parliament Office for Science and Technology (POST)

Lilian Greenwood MP (right) in conversation Madhu Baghel, Newton PhD scholar at the University of Nottingham.

Lord Hunt of Chesterton

Quote from participant:

"It was a lifetime experience to be part of the policy making event conducted by the British Council and Lord Fox. There were several key discussions that highlighted the obvious alarming climatic and environmental situations, along with talks on the betterment of reproducible and authentic science. It was interesting to note that this can be achieved not by thinking individually rather a lot of emphasis has to be given for working in collaboration."

Manoj Kumar, Newton Fund PhD scholar, Francis Crick Institute.

References

1 For more information about the Newton Fund, visit https://www.newtonfund.ac.uk/.

2 Since 2014, the British Council has delivered over 1,000 Newton funded projects addressing global challenges such as combating antimicrobial resistance, ensuring food and nutrition security, and building resilience to natural disasters.

3 Other Newton Fund delivery partners include UK Research and Innovation (comprising the 7 Research Councils and Innovate UK), the UK Academies, and the Met Office.

4 The speech of James Cronin is available online, visit https://www.britishcouncil.org/research-policy-insight/insight-articles/science-and-policymaking

DECARBONISING HEAT WITH GEOTHERMAL ENERGY: ENOUGH HEAT FOR A CENTURY?

Dr Charlotte Adams, Durham Energy Institute, Durham University DH1 3LE

The UK does not have access to the high temperature geothermal resources found in places such as New Zealand, Iceland and the USA, yet it does have a significant low temperature geothermal potential that could supply enough low carbon heat to meet heat demands for a century. Around half UK energy demand is currently associated with the production of heat and targets for the UK to be carbon zero by 2050 mean that finding technology ready alternatives to low carbon sources of heat is essential.

The recent widespread power cuts serve to remind us of how essential continuous energy supplies are for daily life. Some of us may remember the 1973 oil crisis and concurrent miners' strikes that left the UK dealing with an energy crisis manifested as energy shortages and enforced blackouts. The UK government's response at that time was to commission research and development programmes into alternative energy sources including geothermal (Schimacher, 1985). The UK geothermal programme ran from 1977 to 1994 (Busby 2010) and resulted in seven deep wells being drilled. Authors such as Bott *et al*. (1972), Oxburgh (1976), Burley *et al*. (1984) Downing and Gray (1986) and Rollin (1987) produced seminal works on the UK's geothermal potential associated with granites and deep sedimentary basins. This programme identified a total resource of 845 EJ of energy (Busby, 2014) (Figure 1).

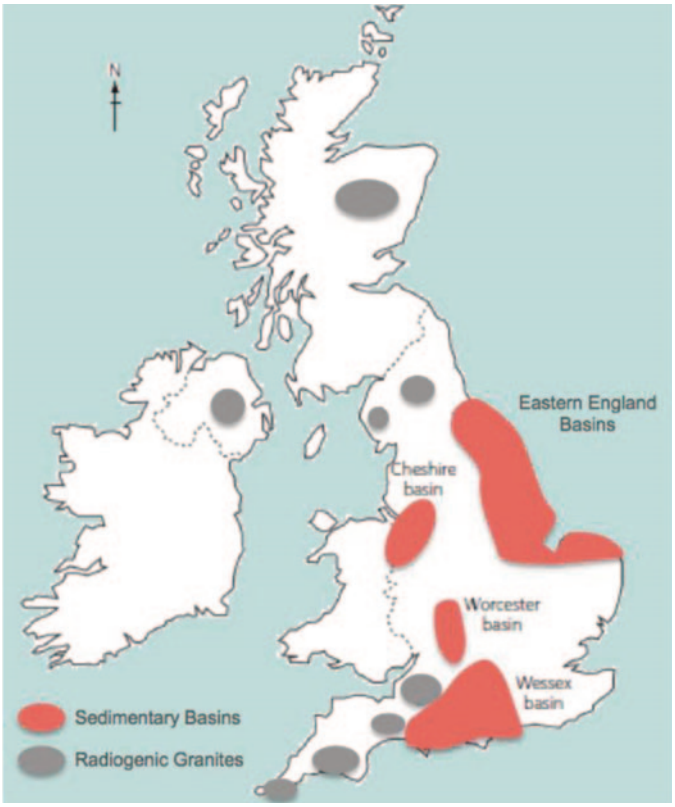


Figure 1 Location of UK's deep geothermal resources

Subsequent to these reviews, further assessment of UK geothermal potential were undertaken by SKM (2012) and Atkins (2013). These did not add much to the original resource assessments and focused on electricity production whereas the UK resource is best suited to heat production.

Despite the potential identified, the adversity experienced by the nation during the energy crisis was quickly forgotten and the UK did not develop its geothermal resource except for the well drilled at Southampton that was developed by a visionary accountant, Mike Smith. This well intercepts geothermal brines at 72°C at a depth of 1.8 km and currently supplies around 2 MW of heat to a range of customers. Despite the success of this scheme it has yet to be replicated elsewhere in the UK. Nearly half a century after that initial work, the UK geothermal resource is again being considered for the decarbonisation of heat not least because geothermal energy is also very compatible with heat networks. Yet upfront capital cost, risk of drilling wells that do not flow and the fact that the value of hot water is far less than an equivalent volume of fossil fuel, stifles the development of a UK geothermal industry.

ACCESSING GEOTHERMAL ENERGY

The means of accessing geothermal energy is similar regardless of geological setting or resource temperature. Normally, wells are drilled to access geothermal fluids and usually a pair (or pairs) of wells are created. This well "doublet" allows for fluids to be extracted from one well and returned to the second well following energy extraction (Figure 2). It is important to maintain separation between the flow and return well to prevent cooling the source. Water is the energy carrier for geothermal systems and it is essential that geothermal targets are capable of both storing and transmitting water to allow us to bring heat to the surface. The Earth's geothermal gradient means that forecasting how temperatures will increase with depth is

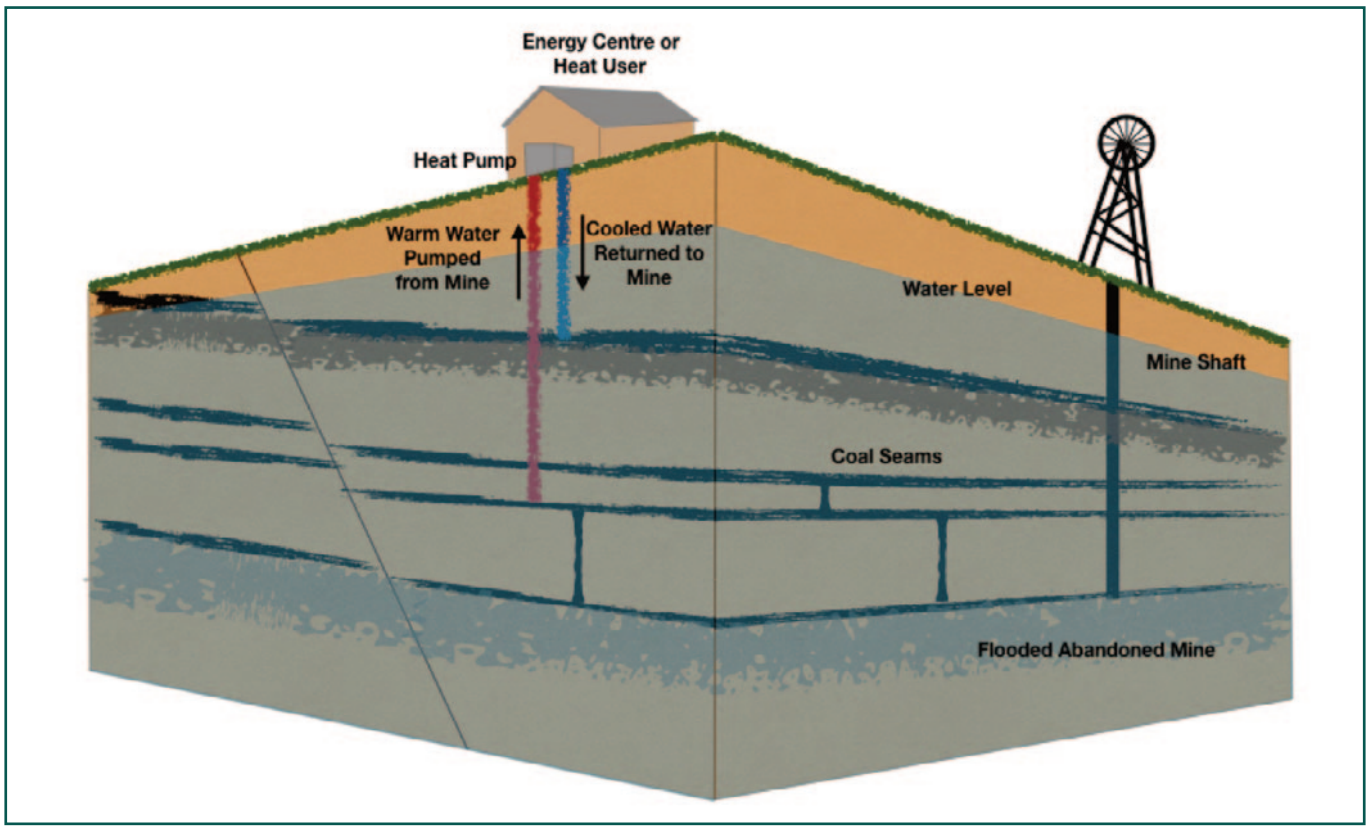


Figure 2 Accessing Geothermal Energy from Abandoned Mines

relatively straightforward but predicting water flows at depth is more complex. To de-risk UK geothermal, research at Durham University focuses upon settings where we are much more certain of water flow. This includes flooded abandoned mines, petroleum wells where fluids are produced in increasing quantities as oilfields age and oil production declines, and limestone cave systems that are buried deep enough to provide a hot geothermal target. Researching these sources allows us to increase both the spatial distribution of geothermal resources and the heat in place over and above that which has been previously identified whilst de-risking production.

MINING HEAT

Many of our towns and cities grew from the coal that lay beneath them and the UK hosted over 23,000 deep coal mines from which around 15 billion tonnes of coal were extracted over the past century (Figure 3). Abandoned coal mines underlie around one quarter of our built environment meaning there is a good correlation between heat demand and resource. The UK has a legacy of galleries and mine shafts that are now flooded with water at temperatures of 12-20°C. Heat pumps can be used to increase temperatures compatible with heating and hot water systems (Adams *et al*., 2019).

Figure 3 UK Coalfields

The UK Coal Authority currently manage this resource and operate several pumping stations across the UK to maintain safe water levels within the mines. These pumping operations currently release around 80MW of heat to atmosphere. The Coal Authority estimate that there is enough heat stored within flooded abandoned coal mines to heat around180 million homes, the UK currently has around 34 million homes. There is also significant potential for inter-seasonal heat storage.

Both heat pump and drilling technology are well proven. Current literature indicates that there are 20-30 mine energy projects globally that provide heating or heating and cooling. These systems have a range of configurations and thermal outputs from a few kW to over

1MW. The earliest mine energy systems have been in operation since 1992 and 1994 in the USA and Canada respectively. This demonstrates that the concept of using mine energy is not new. Given the lower temperatures of mine water, it is possible to also used them directly for cooling allowing heat extracted from buildings to be returned to the mine and used during colder weather.

The Heerlen project in the Netherlands provides 700kW of geothermal heating and cooling to around 200,000 m2 new and retrofit mixed use buildings from wells sunk into the coal workings below the city (Hall *et al*., 2011). The abstracted mine water is circulated around the site, directly to heat pumps which use heat exchangers to extract heat from the mine water and provide heating to office buildings and blocks of flats (Verhoeven *et al*., 2014). The Heerlen project is a primary example of a successful mine water heating and cooling network that has been operating for over a decade (Figure 4). In addition to providing a low carbon source of heating and cooling, the Heerlen project has also delivered economic regeneration to a formerly deprived mining area.

Figure 4 Maankwartier "Moon"

REALISING THE POTENTIAL

The range of operational projects also shows that mine energy systems are relatively bespoke. This highlights the versatility of mine energy systems for varying applications and scales. However, this may also provide a barrier to development as it is difficult to take a "one size fits all" approach which adds complexity to making generalisations in relation to capital, and operational costs. Given we have identified the resource and the technology to access geothermal heat in the UK, we now need a market and regulation for selling heat and government policies such as licensing for geothermal developments, revision of building regulations and planning policy that support its uptake. The renewable heat incentive, whilst it exists is attractive for both low and medium temperature geothermal development but we need to do more. A greater number of demonstrator projects are required to highlight the potential for new and retrofit buildings to use this resource and further support through insurance will help to secure investment. Case in point is the deep geothermal industry in the Netherlands which has doubled in the last 5 years due to their insurance scheme that covers the risk of drilling a well that does not flow. Other countries that have or have had similar risk insurance schemes have also seen growth. In their geothermal industries. The development of UK geothermal resources offers huge potential to decarbonise our heat demand for a century or more whilst presenting new business opportunities and economic growth and we must seize this opportunity.

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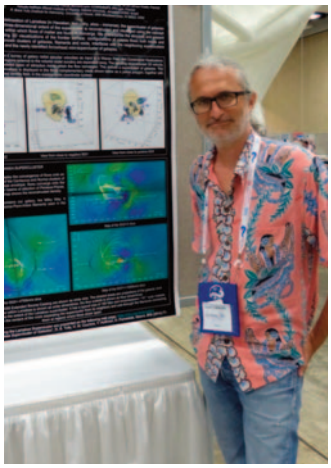
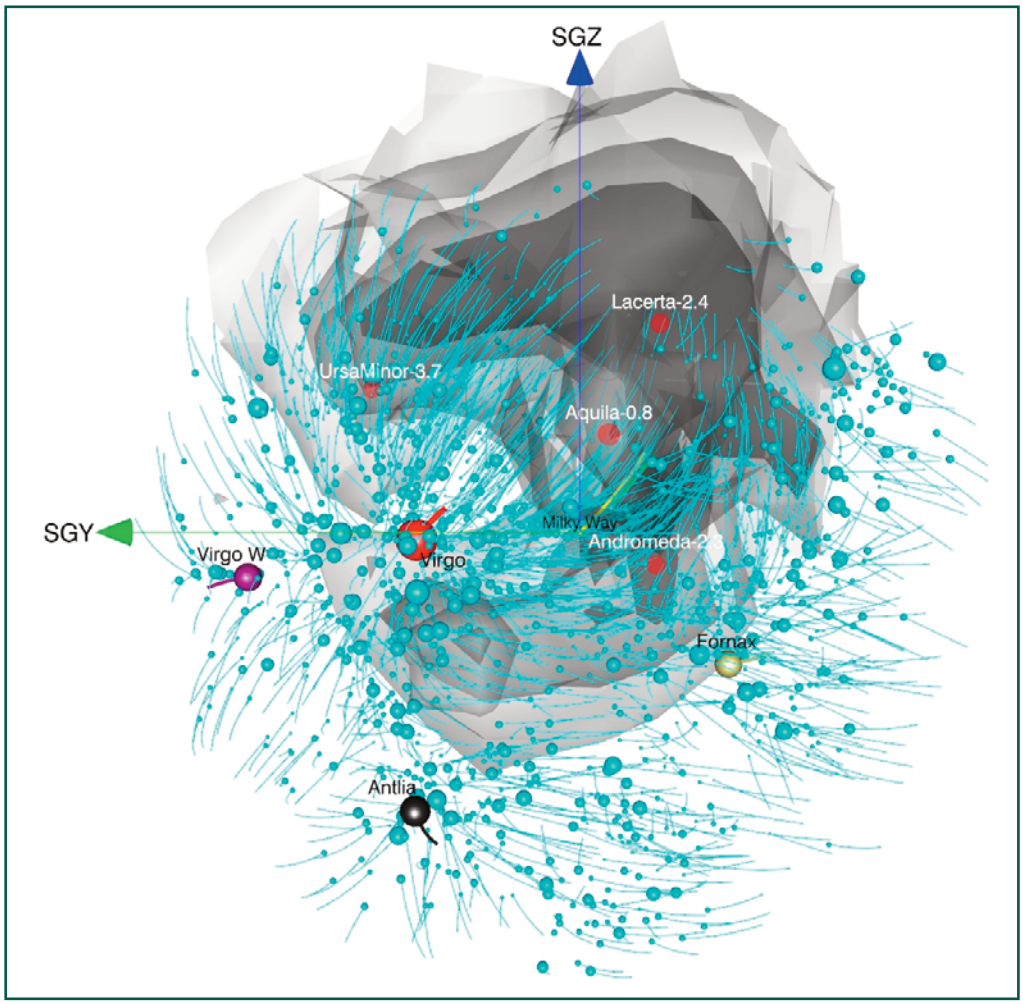
IN SEARCH OF THE LOCAL VOID, THE IMMENSE COSMIC VOID AT THE BORDER OF THE MILKY WAY, OUR GALAXY.



Daniel Pomarede, Université de Paris-Saclay

The Universe as we observe it today was born from fluctuations in the density of matter that occurred in the very first moments of the Big Bang. Regions with above average density spawned galaxies and galaxy clusters, while less dense regions produced cosmic voids.



In 1987, astronomers Brent Tully and Richard Fisher, while mapping nearby galaxies, discovered that our galaxy was located on the periphery of a huge void. It then appeared that the group of galaxies containing the Milky Way and its neighbours, such as the Andromeda Galaxy, formed a wall delimiting one of the sides of this void. In addition, as the material flows from the less dense regions to the denser ones, a phenomenon of evacuation in the Local Void was observed, as it grew larger and emptier over time. There are several points of interest in understanding and studying this void: most of the matter that we are made of must come from this void – it therefore plays a role in our galactic archaeology;

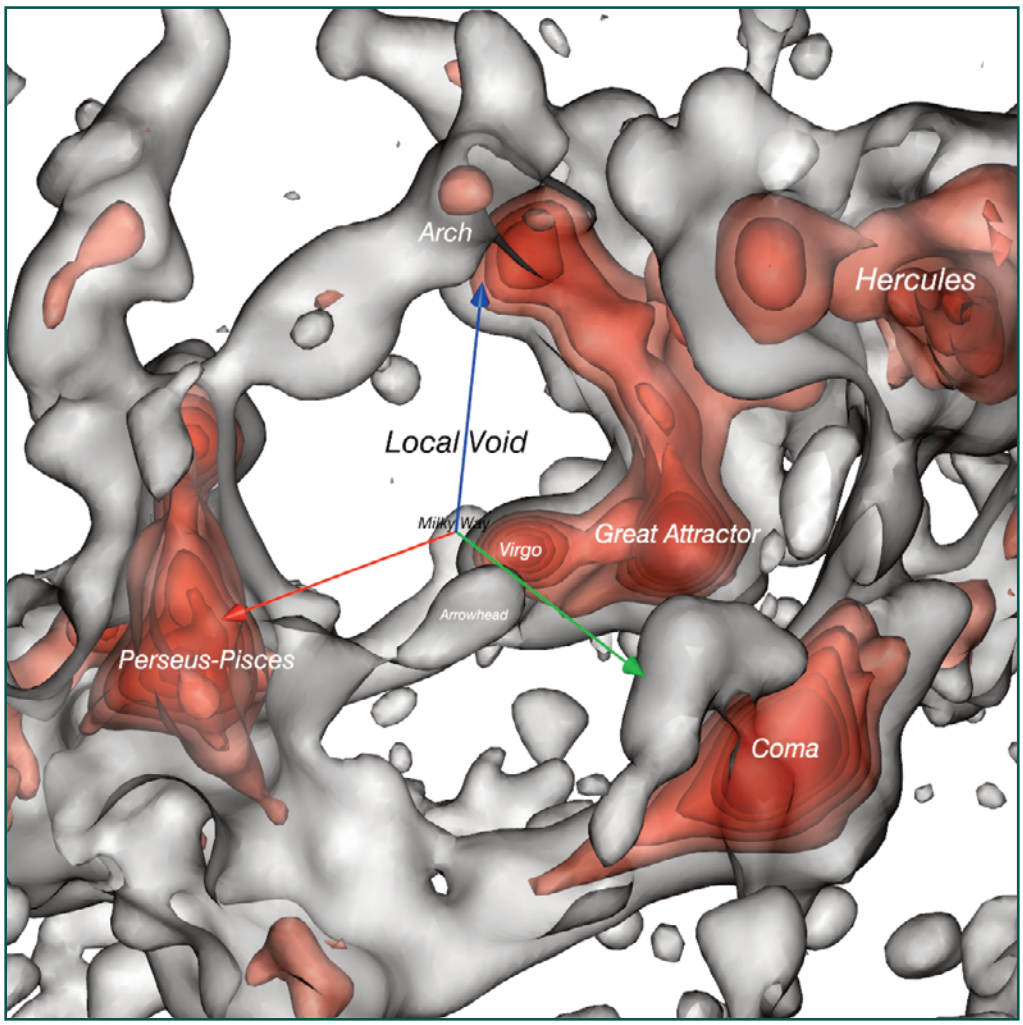
About Université Paris-Saclay

Université Paris-Saclay offers a wide range of education programmes, from bachelor's degrees to doctorates in fields involving natural sciences, social sciences and the humanities. There are currently 65,000 students in the founding and associate institutions, including 9,000 master's students, 4,600 doctoral candidates. www.universite-paris-saclay.fr/en

and voids in general are cosmological probes that are studied to unlock the mysteries of dark matter and dark energy. Unfortunately, a major difficulty has hindered the direct study of this cosmic void: it is located in a region of the sky that is hidden by our own galaxy's disk: the Galactic Zone of Obscuration, which is made up of thick interstellar dust clouds. However, an indirect three-dimensional mapping technique was implemented to overcome this observational difficulty. Using observations of galaxy movements, we have deduced the distribution of mass (and the lack of mass) responsible for these movements and have built a 3D map of it.

This reconstructed map thus reveals a complex and nuanced morphology, with a characteristic size of 60 mega parsecs. Just as over-dense regions organize themselves into a filamentary structure called the "Cosmic Web", characterized by filaments connecting clusters of galaxies, low density regions form a network of deep voids connected to each other by shallow passages, i.e. whose density is slightly lower than average. This chart not only explores the structure of our neighbouring Local Void, but also its relationship with the giant voids that surround it: the Hercules Void, the Sculptor Void and the Eridan Void, which are much better known as they are located outside the Galactic Zone of Obscuration.

Our map lists the emptiest points and names them according to a nomenclature which is based on their positions in the 88 constellations and their distances. Cosmographic details such as the presence of thin filaments of galaxies passing through the Local Void, or the presence of some massive galaxies, can be found on this map.



Our understanding of the Local Void's 3D structure finally allows us to re-examine our speed in the Universe, which remains an important cosmological question. The group of galaxies to which the Milky Way belongs was discovered in 2014 and named Laniakea, which means "Immense Celestial Horizon" in Hawaiian, as it is composed of more than 100,000 galaxies. This supercluster of galaxies moves at a speed of 630 km/s, or about 2.3 million km/h. An estimate of the Local Void's contribution through the evacuation phenomenon gives a velocity of about 200 km/s, with the combined influences of the Local Void's repulsion and the Virgo galaxy cluster (the closest cluster to the Milky Way)'s attraction accounting for 50% of our movement in the Universe. Galaxies therefore do not only move with the general expansion of the Universe, they also react to the gravitational pull of their neighbours and to very massive regions. These results allow us to understand the detailed contributions of the multiple agents involved in this movement, including the Great Attractor, the Shapley Attractor, and the Dipole Repellor, which is another cosmic void located much further away and whose influences have been studied in recent publications.

Video with an embedded player:
https://vimeo.com/326346346
Interactive displays (embedded player possible):
https://sketchfab.com/models/f0a44df256aa4faf93391887d66010e2
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TALENT 2050: SKILLS AND EDUCATION FOR THE FUTURE OF ENGINEERING

Paul Jackson, Jasia Education Ltd. Paul led Talent 2050 for the National Centre for Universities and Business. Paul is well known for STEM initiatives like the Big Bang Fair and commentating on skills issues as the former CEO of Engineering UK and a current school and university board member.

When we kicked off the Talent 2050 project last year we wanted to find out how the skills mix in engineering was changing and what could be done to make certain that the UK has the quantity and quality of skills needed in the future.

The project looked at the wide footprint of engineering, including IT and construction, and we aimed to look at sectors that use engineering skills too, an ever-increasing number, including logistics and retail.

If Britain is to be productive and prosperous, we have a lot to do and the delivery and operation of critical infrastructure over the next few decades will be dependent on getting this right. There is a risk that all sectors will be chasing digital skills for higher productivity and that the models of the past, in education, in recruitment, and professional registration will serve us poorly in the future.

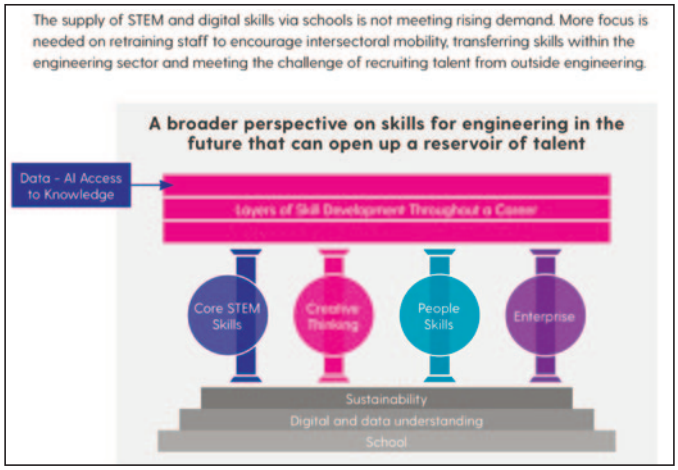
We didn't think the sector needed another skills study that just said there were shortages so we got out into the country and asked real engineers, some senior and many at an early career stage, how they saw the skills needs changing and what was good and bad about the education system. They were happy to share!

We talked to groups from Southampton to Glasgow and London to Sunderland, helped out by Universities and employers around the country. This isn't a study to leave on the shelf so we involved politicians, academics and business leaders in a liaison group of people that wanted to and have the influence to make things happen. Our sponsors, Barclays, Pearson, NATS and London South Bank University both funded and facilitated the work which has been undertaken through the education and employers' leadership charity, the National Centre for Universities and Business.

The net result has been six key recommendations which cover recruitment barriers and bottlenecks, changes to education and support for "intersectoral" mobility, which is a term we use for opening up recruitment into engineering to a fantastic reservoir of talent; this is a significant change from expecting everyone to have followed very similar STEM learning routes and rejecting many people along the way as "leaks" in the talent pipeline.

METHOD

The baseline Rapid Evidence Assessment (REA) for STEM (including digital) skills focused on current supply and potential future demands using 40 sources. Subsequent material from Pearson (Commission on Sustainable Learning for Life, Work and a Changing Economy) and Universities UK/CBI (Skills needs in England – the employer perspective) emphasised the need for lifelong learning through a more effective and flexible system and the Commission estimated a £108bn gain to the economy in getting the right mix.



We used workshops and an advisory group to tap into the hopes, aspirations and expertise of 150 people, asking them to think about the disruption coming, the skills needed to handle new challenges and how learning could be supported, educationally and through funding. Workshops were held in Sunderland, Rochester, Glasgow, London, Birmingham and Southampton. In addition to individuals from public and private sectors, education and professional bodies, we worked with a group of final year secondary school students to hear from those who will be actively productive in 2050.

The workshops and evidence assessment found that STEM initiatives have helped increase the supply pipeline from education, but demographic trends and migration effects have outweighed those impacts. They also highlighted that very significant barriers and bottlenecks persist, and the engineering sector's poor record on diversity has not been adequately addressed.

DIVERSITY

Recruitment and selection processes are not currently optimised to enhance diversity. Fixed qualification requirements, eg A-level physics and Chartered Engineer registration, are seen as barriers.

The supply of STEM and digital skills via schools is not meeting rising demand. More focus is needed on retraining staff to encourage intersectoral mobility,

transferring skills within the engineering sector and meeting the challenge of recruiting talent from outside engineering.

Feedback from the workshops suggested significant potential to recruit from alternative sectors and provide the appropriate engineering knowledge through a mix of training and/ or access to the knowledge base. The current model in engineering assumes a pipeline of individuals building a large resource of engineering knowledge, whether through a university or apprenticeship route. This is then augmented over the years by people skills, management, communication and business, to provide that broader skillset in a career. It is a T shape, where the technical knowledge has to exist before other elements – the horizontal part of the T – can be added. This creates the "leaky" pipeline of talent with no potential to top up later. Additionally, key qualifications in that pipeline are skewed towards male participation, for example, A Level physics has a 4:1 male-female ratio and computer science 9:1.

RECOMMENDATIONS AT A GLANCE

Recruitment barriers and bottlenecks

1. Engineering needs to reach beyond existing STEM employees and change the perception of recruitment from the "leaky pipeline" to a "reservoir of talent", ready to learn.
2. Consider a more inclusive approach where recruitment or enrolment (including professional registration) is based on the potential to gain the right skills rather than previous attainment.

Changes to education

3. Digital skills, including AI, and environmental protection, provide the foundation for future change and need to be fully integrated in an industrial strategy that embraces interdisciplinary working. They also need to be at the heart of future education more widely.
4. The education system needs to embrace technology for learning, including smart phones, to prepare the next generation to access, filter and apply knowledge that is available online.

Supporting intersectoral mobility

5. Ensure upskilling and reskilling are fully supported for those in work, whether within the sector or bringing complementary skills through intersectoral job mobility. This should be regionally tailored and applicable to SMEs, and those in the gig economy as well as major corporations.
6. The education and skills system needs more collaboration between the public sector (national and regional), educators and employers to share resources, set priorities together and support employees, the self-employed and those without employment in a sector or at all.

The skills suggested in the workshops expanded on those identified in the Rapid Evidence Assessment. Three skills pillars were suggested: people skills, creative thinking and enterprise, alongside core technical knowledge. It was also noted that ethics will become increasingly relevant as technology changes and artificial intelligence creates opportunities to exploit the existing knowledge base across all occupations.

Could the intersectoral recruitment approach work? We have found some good examples where it has. The Open University is an obvious one where there are no specific qualification requirements to take an undergraduate programme. Of course this isn't just about degrees; the Sky Academy trains and recruits into the company's IT workforce and has challenged the stereotypes to find talent, and particularly a diverse group.

Sky's website says: "It really doesn't matter what you've studied. Genuinely." They do look for an interest in technology and motivation to join their team, rather than specific qualifications and Conrad Langworthy, Head of the Software Engineering Academy at Sky told a Telegraph Leaders of Change Conference earlier this year that Sky was now recruiting a 50:50 gender balance into IT roles as a result of the courses offered and the approach taken, very different to the 9:1 male:female ratio we report for computer science in schools.

Can engineering and specifically those involved in infrastructure do the same? We believe they can and indeed must. This doesn't mean that the depth of knowledge in structural engineering should be reduced in critical roles but it does mean that there are many roles already and more to come where wider skills, communications, enterprise, digital, will be essential and some of the STEM skills can be added later.

This change will need a funding system to support it, which could build on employer schemes, career development loans and the apprenticeship levy. It will need a proactive approach to recruitment which could be supported by the professional engineering institutions as mentors to a more diverse group entering the profession at different stages of their careers rather than gatekeepers to professional registration. It will work best if we can embrace digital tools for learning at all stages of education, including in schools.

Talent 2050 has identified that the profession could look very different in the future and the change has already started. It will need to accelerate if the UK is to be at the leading edge of the next industrial and social revolution and may look very different to the system of education and professional registration developed in the last century.

The full research pack is available from the National Centre for Universities and Business.

http://www.ncub.co.uk/reports/talent-2050-engineering-skills-and-education-for-the-future

SKILLS IN THE PHARMACEUTICAL INDUSTRY: WHERE WE ARE AND WHERE WE'RE GOING

Andrew Croydon
Director of Skills & Education Policy and Examinations at the Association of the British Pharmaceutical Industry. Before that, he was Head of a co-educational Senior School.

Medicines are one of the greatest hopes we have for the future of human health, helping us live longer and better lives. The Association of the British Pharmaceutical Industry is the trade association representing the UK-based pharmaceutical companies that are developing the treatments of the future.

It is of the utmost importance that our industry, and the wider life science ecosystem, can recruit the right people with the right skills. Everything we do is to benefit patients, but what we aim to do is only achievable by having an innovation-ready and sustainable workforce.

Working in the STEM environment, or, as is increasingly popular to label it, the STEAM environment (A being for Arts), provides a fulfilling career. Across life sciences, there are many roles which contribute to the jigsaw of scientific knowledge and understanding which support delivery of life changing medicines.

But knowledge and understanding in the workplace must be complemented with possessing the right skills – skills that span both the core and the specialist.

DIAGNOSING THE SKILLS PROBLEM

In order to inform industry understanding of where the priority skills gaps exist, the ABPI has undertaken regular rigorous analysis of skills needs since 2005. The good news is that the latest report published in 2019, noted a significant reduction in concern about scientific and mathematical knowledge.

We attributed this improvement to consistent effort over time to improve the quality of the scientific and maths curriculum in schools. Application of this knowledge is, however, still a concern and can be considered a problem which still needs solving.

As well as core skills, the ABPI skills report addresses specialist skills. Successive iterations of the report have consistently identified recruitment challenges in areas such as clinical pharmacology, and as a result, the ABPI has sought a collaborative approach to mitigate this high priority concern.

The Clinical Pharmacology Skills Alliance (CPSA), a collaboration between the ABPI, the British Pharmacological Society, Health Education England and the Faculty of Pharmaceutical Medicine, was formed out of a common desire to develop and support a long-term, cross-sector action plan for clinical pharmacology and knowledge of medicines discovery and development.

With the aim of improving the clinical pharmacology skills pipeline to support both healthcare and life sciences sectors for the benefit of patients and the UK economy alike, the CPSA now serves as a prime example of a cross-sector initiative successfully addressing a specific skills gap.

Although there remains a challenge with clinical pharmacology skills needs, I am encouraged by somewhat diminished severity reported this year, and as such, similar skills focused cross-sector collaborations could well have a similarly significant impact on the skills needs facing the STEM environment.

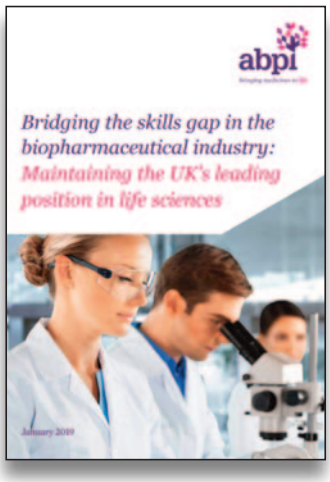
As well as an evolving need in clinical pharmacology, the ABPI

abpi
Bringing medicines to *life*

skills survey showed the rapid emergence of high priority need for skills in immunology and genomics, driven by an equally rapidly evolving scientific environment.

In addition, data science emerged as a critical area, with skills in informatics, computational, mathematical and statistical areas in growing demand, particularly in interdisciplinary areas such as chemoinformatics.

It remains clear these skills gaps must be addressed if we are to avoid wide ranging detrimental effects, such as losing our world-leading position in clinical trial performance in therapeutic areas such as cancer and immunology.



BREXIT AND THE FUTURE OF SKILLS

Between the 2015 and 2019 ABPI skills reports, skills drop to the second most critical issue affecting job growth. The most critical issue was Brexit.

Science thrives on collaboration, knows no geographical boundaries, and the global movement of intellectual knowledge, ideas and skills has become an integral and mutually beneficial part of workforce planning.

As skilled workers are in high-demand and increasingly globally mobile, the UK's future immigration system must continue to attract global talent and encourage the retention of those working in the UK.

Consequently, guaranteeing the rights of researchers and specialists in science and, continuing to attract the brightest and best scientists to the UK remain crucial.

of world leading initiatives and effective support.

I speak from experience when I say one of the greatest areas of support which can be provided at school level, is to enable pupils to make informed career choices, and never has this been more important.

Whatever the outcome, failure to access to the best STEM skills will have far reaching implications for current and future generations not just in the UK, and not just for the success of researching and developing medicines, but across all STEM disciplines throughout the world.

CAREER CHOICES: GETTING PUPILS EXCITED ABOUT STEM JOBS

Equally crucial for keeping pace with global competitors and remaining at the cutting edge of innovative science, is the nurturing our own home-grown talent.

This is something which requires the right skills and education policy framework, continuation and enhancement

Life sciences is among a select group of highly innovative industries linked to science and tech which could be responsible for a new wave of growth worth an extra £14 billion a year to the UK economy by 2025.

Specifically, life sciences could have the biggest impact, not only adding extra growth to the economy by 2025, but also, an estimated additional 31,400 more jobs to the almost quarter of a million people currently employed across 5,870 businesses in the UK.

Clearly, investment should start in schools which is why we are working with career advisors in schools and universities to support labour market research informed Career Education Information Advice and Guidance (CEIAG).

THE PROMISE OF APPRENTICESHIPS

The ABPI is working to break down the barriers to the lack of parity between traditional academic and vocational routes into careers in industry.

Many find it interesting to learn a significant number of employers believe higher level apprentices are more likely to be work ready individuals, as they have a competent grasp of the skills needed to fulfil specific roles when compared to those entering employment via other routes.

We believe high quality apprenticeships can address gaps in skills and provide significant support to the future life sciences skills pipeline, all of which is critical if the UK

Government is to achieve its commitment to boost spending on R&D to 2.4% of GDP by 2027.

Having been an early adopter of higher-level apprenticeships, in 2018, the pharmaceutical industry in the UK recorded a 4 year high in apprenticeship starts – a 169% increase since 2013; all mostly at level 4 and above.

The vast majority of these high skill roles were new recruits. Nevertheless, the Science Industry Partnership (SIP) 2018 apprenticeship survey showed the pharmaceutical industry has only been able to deploy 6% of its levy contribution under the current policy.

Given the industry commitment to development of skills through this route, consider what could be achievable with less mismatch between policy and business realities.

The ABPI has outlined policy solutions for the Government to consider which cover: flexibility to address business realities; improving perception; securing the UK's wider life science sector with effective transfer of levy fund.

Specifically, ABPI proposes ring-fencing of the £12 million unspent life sciences' apprenticeship levy to fund, amongst other initiatives, NHS apprenticeship programmes for healthcare professionals involved in research, genomics, and in the administration of advanced therapies and other new specialist technologies.

The pharmaceutical industry is forward looking in other areas of lack of parity and discrimination too.

GETTING MORE WOMEN INTO STEM

Nowhere are we more committed to breaking down barriers than in our efforts to encourage women into STEM.

This focus feeds into both the direct careers support we provide, as well as the award-winning resources for schools which we provide – resources which span UK science curricular, promotion of numeracy, engagement with global issues such as antimicrobial resistance, and those that inspire young people to consider the industrial strategy grand challenges.

We are encouraged by the report this year that the number of girls taking science A-levels was more than boys for the first time but, we know there is still much more work to do.

We must break down all the barriers which prevent the people with the right skills – regardless of gender – feeding the skills pipeline. We will continue to be proactive in such areas, and we can't afford not to be.

THE FUTURE IS DIGITAL

No article about skills in 2019 would be complete without mentioning digital skills. Running across all levels of STEM education and training are digital/data/AI needs.

Earlier this year, two thirds of UK companies reported to the CBI they have unfilled digital skills vacancies, and 95% of companies expect their digital skills needs to grow, never has it been more important to address the integral nature of these skills to effective cross functional working.

Many STEM related fields, life sciences included, are not the obvious choice for students and graduates with digital skills who want a career which utilises their expertise.

Currently, there is stiff competition from wide-ranging sectors to recruit from the same pool of talent. Apprenticeships can help, and the level 6 data scientist standard is a great vehicle for support in this area of need, but apprenticeships alone will not bridge the skills gaps.

WHERE WE GO FROM HERE

The UK Government has recognised the importance of skills development, with commitments across the Industrial Strategy, and specifically within the Life Sciences Industrial Strategy and Sector Deals.

It is essential therefore, that ongoing and future initiatives address both current and anticipated future skills needs based on the changing STEM ecosystem, and the ABPI will continue to work tirelessly to lead and support a robust and sustainable skills pipeline for the benefit of all.

STEM EDUCATION AND SKILLS

Dr Hilary Leevers
CEO, Engineering UK

It was a pleasure to speak at the Parliamentary and Scientific Committee's July's session on STEM education and skills.

At EngineeringUK we are passionate about demystifying the world of engineering to inspire all young people from all backgrounds to consider a career in engineering. Working in collaboration with educators, government and industry, we aim to grow and diversify the talent pool and help young people realise their potential.

Many young people are motivated by the need to address global challenges, such as ensuring access to clean water, sanitation and affordable and sustainable energy, but they may not realise how central engineering is to creating solutions to these problems.

Over a quarter of UK enterprises are involved in engineering, employing more than five and a half million people. Demand for engineering skills is high and will continue to rise in the future – EngineeringUK* estimates that, on average, the annual UK need is:

- Around 200,000 roles requiring engineering skills including
- 124,000 engineers and technicians with core engineering skills.

Currently there is an annual shortfall of up to 45,000 engineering graduates and technicians for core engineering roles and nearly half of engineering employers report recruitment difficulties.

There's a critical shortfall in the young people on pathways to fill future jobs but we shouldn't be aiming to resolve this by simply encouraging more people to study science, technology, engineering and maths (STEM).

At EngineeringUK, our commitment to equality, diversity and inclusion emphasises the need to increase the diversity as well as the number of young people choosing academic and vocational pathways into engineering.

GENDER DISPARITY IN ENGINEERING

One of our 2019 research reports examined female under-representation in an industry where women make up just 12% of the workforce.

The workforce disparity is largely due to girls dropping out of educational pathways at every decision point, despite generally performing at least as well as

boys in STEM (science, technology, engineering and maths) subjects at school. The pattern is repeated for apprenticeships with 1 in 10 of those on engineering-related apprenticeships being female. Our research shows that only 60% of girls aged 11 to 14 think they could become an engineer if they want to, compared to 72% of boys; only a quarter of girls say they would ever consider a career in engineering.

SOCIAL MOBILITY IN ENGINEERING

Further evidence from the EngineeringUK report on social mobility revealed that while young people from lower socio-economic backgrounds have reasonable access to engineering careers, they do not progress at the same rate as their more advantaged peers.

An unequal provision of science-related subjects across the country is a barrier, with deprived areas more likely to face teacher shortages, have STEM subjects taught by non-specialists, and poor availability of science options. This potentially affects young people's opportunity to continue to study subjects like physics, which can have a knock-on effect for undergraduate degrees and routes into engineering careers.

The report also identified patchy careers guidance as an obstacle to social mobility, with students from deprived areas needing more access to high-quality careers guidance.

ETHNICITY IN ENGINEERING

Just 9% of those working in the engineering sector are from Black, Asian and Minority Ethnic groups compared to 12% of the UK workforce. We see that uptake of STEM varies across different ethnic groups with Indian, Pakistani and other ethnicity students more likely to study STEM subjects compared to Black African and Caribbean groups.

THE CASE FOR CHANGE

Our analyses suggest that great talent is being lost at each educational decision point leading to an under-representation of girls, women and people from some BAME communities. We will continue to examine the evidence considering other important and often under-represented groups, such as people with disabilities.

There's a compelling business case for the sector to widen its talent pool. This goes beyond securing the numbers of engineers we need – workforce diversity improves innovation, creativity, productivity, resilience and market insight, and should enable more people from different backgrounds to benefit from engineering and technology products and services.

We've all heard about technology that can perpetuate privilege - such as AI that deflects questions on feminism or facial recognition systems that are inaccurate with non-white faces. We need to enable more young people from under-represented groups to participate in STEM education and engagement and ensure that this participation is impactful for them, so that they have a stake in and can influence the engineering world around them.

This is also about equality - we believe that all young people should have the opportunity for fulfilling and rewarding careers and that engineering careers have the potential to break intergenerational cycles of poverty.

EngineeringUK's EDI vision is for young people from all groups to be proportionately present in and well-prepared for engineering pathways at 19 years of age.

HELP US TO BREAK DOWN THE BARRIERS

But what can we do to enable young people from all backgrounds to stay on STEM education pathways? The Royal Academy of Engineering's report *'Engineering skills for the Future: the 2013 Perkins Review revisited'*** (January 2019) identifies a number of recommendations; we are collaborating with others to work on those we can deliver. But a number of recommendations need government support, from supporting STEM teacher retention and development to reviewing post-16 academic pathways to engineering. The recently published National

Engineering Policy Centre's *Engineering priorities for our future* reinforces the recommendations of the Perkins' review and also highlights the need to invest in research to understand which interventions are most impactful in affecting young people's decision making and meeting our skills needs***. We would welcome the support of parliamentarians in turning all of these recommendations into reality.

around 50,000 young people are expected to take part in the same school assembly at the same time. The *Big Assembly* will feature inspirational engineers from across sector. The wider week of activity will highlight how engineering can be the choice to fulfil young people's dreams of rewarding careers.

Our research tells us that 9 in 10 young people would like a job with a purpose and almost

stereotypical image of the engineer and engineering among the wider public and will see engineering organisations, engineers and supporters like Amazon, Ocado and Facebook showcase what 21st Century engineers and engineering really look like.

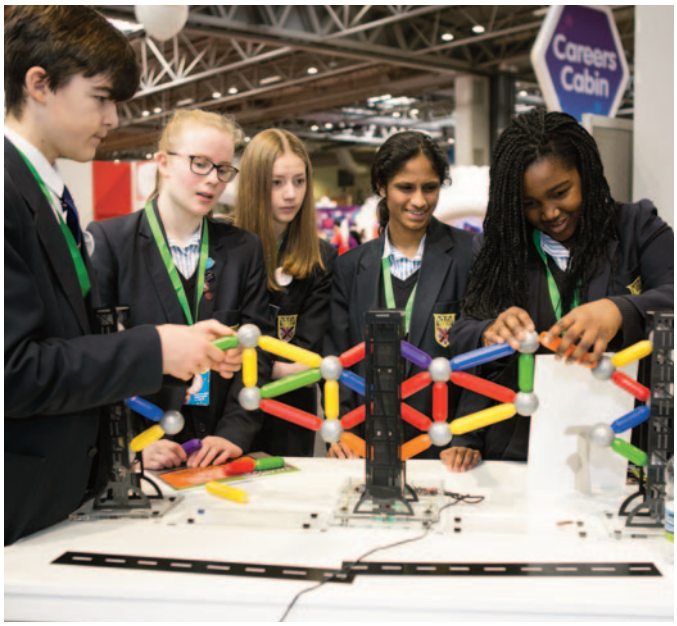
THE BIG BANG

Giving students opportunities to engage with real-life engineers and scientists is central to our careers activity and

with 80,000 teachers, students and parents attending, complimented by more local Big Bang Near Me Fairs

Visitors to Bang Fair (11-14 March 2020) get to see amazing new technologies in action: from piloting a drone and building a model jet engine to creating a 3D selfie and seeing inside your own eye.

By making these opportunities available to everyone, we hope to show that STEM careers are



Parliamentarians are also ideally placed to broker relationships between charities and local businesses and amplify our work and messages.

Early November will see the launch of the long-established annual campaign *Tomorrow's Engineers Week* (4-8 November) which aims to change the perception of engineering among young people, their parents and teachers and inspire future engineers. This year's campaign will spotlight how our engineers are on a mission to improve the nation's health and wellbeing.

At the heart of the Week will be a *Big Assembly* where

two-thirds (64%) of parents want their children to have a job that is something they can be proud of.

With such public demand to hear about worthwhile careers, the Wednesday of *Tomorrow's Engineers Week*, will see the Royal Academy of Engineering unveil the next major moment in its *This is Engineering* campaign, *This Is Engineering Day*, a new national awareness day dedicated to publicly celebrating the engineers and engineering technicians shaping society and solving global problems.

This year, *This Is Engineering Day* is focused on changing the

helps support schools to meet some of the key Gatsby benchmarks for Good Careers Guidance.

Parliamentarians can encourage schools, educators and employers to give young people the chance to meet industry professionals and really get hands-on with engineering. Research shows that interactions with real-life engineers help young people to discover how fulfilling, diverse and exciting careers in modern engineering can be. Literally tens of thousands of these encounters occur each year at the annual Big Bang Fair, held over four days at the NEC in Birmingham

within the grasp of the majority rather minority. We know that only by collaborating with policymakers, educators, industry and charities will we be successful in inspiring tomorrow's engineers.

References

* From EngineeringUK's flagship publication The State of Engineering: https://www.engineeringuk.com/research/engineering-uk-report/

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STEM SKILLS FOR LIFE

Professor Josie Fraser, Deputy Vice Chancellor (Acting), The Open University

There's no question that the UK has, for a long time, punched above its weight in the area of scientific innovation. Our output of patents per head of the population for example, makes the case very strongly. I would argue that much of this innovation is driven by our world-class higher education institutions, where research-led teaching opens up STEM knowledge and STEM thinking for thousands of students every year. STEM-based companies make up more than half of the FTSE 100, and the contribution to GDP that STEM makes to our economy is vital.

Indeed, there is a strong economic imperative to improve flexible learning opportunities to improve the life chances and employment outcomes of those wishing to change or improve their careers, particularly in STEM. As well as increasing productivity of businesses through addressing skills shortages and upskilling existing employees. So we have many reasons to focus on increasing the take up of STEM education if we want the UK's reputation for innovation (and the associated contribution to our economy) to continue.

However reports that fewer students are choosing Chemistry at University are in the news as I write.

The proportion of women entering Engineering and Technology subjects and jobs remains lower than we want (and need) it to be. And for many years, the STEM skills gap has been a huge concern for employers who need these vital skills in the workforce.

In addition the pace of change now feels faster than ever, and is only going to increase; meaning jobs will exist in 15 years that we can't imagine now, and jobs we think of as human will in future be done very differently. In this age of the 4th Industrial Revolution with AI taking over more functions and providing ever more data, we must have algorithms that don't bake in unconscious biases and analysts with diversity of thought, training, and life experience to draw on. We need more women in tech and engineering, we need to encourage BAME participation in subjects where there is currently a disproportionately white workforce/student body. For all of these reasons, we must incentivise an approach to STEM skills that will allow people to retrain and reskill, in a flexible way, as the workforce labour market changes.

All this makes the case that we have an urgent need to ensure that STEM education is available to the broadest section of the UK population *for life*. Those who currently don't think STEM is for them must be catered for, so they feel not just included, but actively encouraged to participate.

The STEM skills gap cannot be solved by focusing on the young alone – the gap is too large and the need too urgent. The changes coming also need us to consider how we support people to change direction whose jobs may no longer exist in the future. Therefore, it is essential that we focus on supporting adults to upskill and reskill in STEM.

This underlines the importance of cementing a lifelong learning culture across the UK. It is essential that UK government policies incentivise and support this. By that, we mean making lifelong learning affordable, accessible to all and delivered in partnership across the post-18 sector with industry must be the goal that policy supports.

In my role at the Open University, having come from a more conventional campus career, I have been amazed at the sheer scale and reach of flexible distance learning. Supporting people to study part-time, while working, without travel (for the most part) is in my view the key way to deliver STEM skills, throughout life, to people who want or need to retrain.

This is because online delivery offers a cost effective, large-scale solution that also gives the flexibility people need to fit study around busy working lives. The Open University's open access policy means that anyone can study with the OU irrespective of previous learning. This offers genuine educational opportunities to promote social mobility. A third of our students come without 2 A levels. This means people who made other choices at a younger age, or who want to switch to STEM, don't have to fit in a couple of years of night school A levels before they can even apply. And 50 years of experience supporting a wide range of people from a wide-range of backgrounds and experience to cope with STEM subjects through innovative teaching and learning means that the OU can enable all people from all backgrounds to succeed.

So I firmly believe the OU, alongside other Universities, FE colleges, the Institutes of Technology and employer partners, can and should be incentivised to deliver STEM skills to adults as well as the post-16 young person demographic. There are many ways the OU offers online learning, for those interested in acquiring STEM skills. These include free short online STEM courses to boost confidence (including Badged Open Courses and Massive Open Online Courses) or courses specifically designed to help women and others return to STEM careers. The OU delivers hands-on lab skills through online learning including OpenSTEM Labs, a multi-award winning lab that gives access to real scientific equipment and experiments that students can control just as if they were in the room. The OU is also tackling data science skills shortages by matching industry needs with access to appropriate training.

I really welcome the initiatives that focus on encouraging young girls to consider technology and engineering, physics and maths, to help us boost the balance. I still do science outreach talks at local schools when I get the chance. But we have to combine that with thinking about the parents of those children – people who didn't think science or maths or engineering or technology were 'for them' when they were younger, but who can see the opportunities around them. These are people who can't return to a campus for 3 years, they have kids, mortgages, bills to pay. How do we help them to reskill? A free short course can encourage, build interest and give people a taste. What do we do to build upon that to ensure the complex needs of industry to meet the digital skills gap, the engineering gap, the data science challenge, the diversity problem in all of these disciplines, can be met?

I envisage UK government policy that encourages people to take up opportunities in part time flexible learning that is industry influenced and led. And that supports those institutions taking measures to build diversity into who they train for these vital jobs in our economy.

Just as we've seen that diversity on Boards helps companies to be more profitable, diversity of thinking in our STEM companies can only further improve the innovation for which the UK is rightly known. UK government can have a key role in encouraging that diversity and supporting flexibility in training to ensure that we continue to be world leading.

MANAGING OUR PLUTONIUM LEGACY

Neil Hyatt
Department of Materials Science and Engineering, The University of Sheffield, Mappin Street, Sheffield, S1 3JD, UK.

Sellafield is home to almost 140 tons of separated plutonium, the largest quantity of material under civil safeguards anywhere in the world. Government is still to make a final decision on the whether to reuse this material to fuel a new fleet of nuclear reactors, or whether to immobilise and dispose of it as waste. Here, we consider whether Government's preferred option of reuse is realisable, and scientific underpinning required to deliver the alternative disposal option.

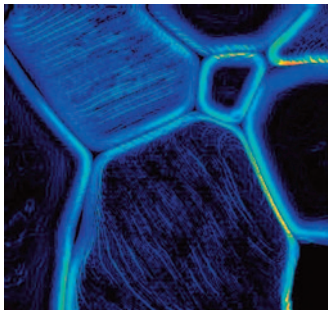
Used nuclear fuel has been reprocessed at the Sellafield site for five decades, latterly to produce plutonium to fuel a fleet of next generation fast breeder reactors. The decision to cancel the UK's fast reactor development programme in 1994, afforded a growing stockpile of plutonium, as reprocessing continued in fulfilment of commercial contracts. The UK plutonium stockpile is held in safe interim storage at Sellafield, to the highest standards of security, awaiting a final government decision on its disposition.

There are two conceivable end points for plutonium management, reuse as fuel in a new generation of light water reactors or disposal as waste material. In its accounts, the Nuclear Decommissioning Authority has made provision of £10 billion (discounted) against the cost of UK plutonium management. A period of prolonged storage will be required to support delivery of both end points at a projected cost of ca. £3.5 – 4.5 billion. However, indefinite storage of plutonium is itself not a sustainable option, due to the need to periodically replace degraded packaging. A proportion of the plutonium canisters at Sellafield are known to be degrading faster than anticipated, and will be repackaged over the next decade at a cost of £1 billion.

Government set out its policy for long term plutonium management in 2011, stating *"For nuclear security reasons the preferred policy for managing the vast majority of UK civil separated plutonium is reuse and it therefore should be converted to MOX fuel for use in civil nuclear reactors. Any remaining plutonium whose condition is such that it cannot be converted into MOX will be immobilised and treated as waste for disposal. Only when the Government is confident that its preferred option could be implemented safely and securely, that is affordable, deliverable, and offers value for money, will it be in a position to proceed with a new MOX plant"*.

Whilst the policy position to reuse plutonium in MOX clear, it remains far from clear that this policy is deliverable.

There are three key challenges to implementation of current policy for plutonium reuse as MOX fuel. First, EDF, as the owner / operator of current, future and planned light water, has shown no public interest in utilising such MOX fuel; indeed, the Generic Design Assessment for Hinkley Point C, *excluded* the use of MOX fuel. Second, as assessed by OECD / IAEA, uranium resources are thought to be sufficient to meet requirements of projected growth of civil nuclear power to at least 2035, and thus the economic driver for MOX will remain weak. Third, although MOX fuel production is generally considered technically mature, based on performance of the MELOX plant in France, this assumption is challenged by the poor performance of the Sellafield MOX Plant and decision to abandon the US MOX Fuel Fabrication Facility, both due, in part, to technical challenges.



The alternative to plutonium reuse as MOX fuel is immobilisation and emplacement in a deep geological disposal facility, as a waste material. Immobilisation technology will, in any event, be required to treat at least 5 % of the stockpile which is considered unsuitable for re-use as MOX fuel. In simple terms, the approach is to incorporate plutonium at the atomic scale within an insoluble mixed oxide material, referred to as the *wasteform*. Arguably, the disposal system safety case for such fissile material should place emphasis on the near-field engineered barrier system, rather than the far-field geological barrier which relies on dilution and long migration time of radionuclides. The key concern is release of plutonium from the waste package and subsequent concentration, leading to a criticality event. To address this concern, the engineered barriers (wasteform, container, and backfill materials) can be designed to minimise plutonium release from the disposal system. The wasteform, as the source term for plutonium release should be designed to be resistant to corrosion and radiation damage. In principle, such a disposal concept also greatly simplifies the disposal system performance assessment, since the physicochemical processes of wasteform alteration and near field interactions can be understood and modelled with much less uncertainty than coupled thermo-hydro-mechano-chemical processes involving migration through the geological barrier.

From the forgoing arguments it will be appreciated that the design, formulation and manufacture, and performance assessment of the immobilisation matrix is of critical importance, to be confident that

disposition by immobilisation and disposal is deliverable. A fundamental conceptual challenge is the design of an immobilisation matrix to assure containment of plutonium over a sufficiently long time frame. We are concerned primarily with plutonium-239, with a half life of 24,000 years, which will almost fully decay after 240,000 years (i.e. 10 half lives), a period of time roughly equivalent to entire history of anatomically modern humans. Nevertheless, this is a relatively short period of time in comparison with geological events and relationships, measured in millions or hundreds of millions of years. Uranium and thorium minerals which survive over geological timeframes therefore provide excellent synthetic material targets for a plutonium immobilisation matrix. One such mineral is zirconolite, a complex oxide of calcium, titanium, and zirconium, examples of which have been dated to in excess of 500 million years.

Over the last five years, supported by the Nuclear Decommissioning Authority and Engineering and Physical Science Research Council, we have developed wasteforms and processing technology for plutonium based on natural zirconolite, in partnership with the National Nuclear Laboratory and Australian Nuclear Science & Technology Organisation. The hazard of working with plutonium means that for reasons of cost and safety, early proof of concept research utilises the elements cerium or uranium as chemical analogues. This has enabled us to build a comprehensive understanding of the mechanisms of plutonium incorporation within the crystal structure of zirconolite at the atomic scale, controlled by material composition and conditions of manufacture. The candidate manufacturing technology for production of plutonium wasteforms is hot isostatic pressing, which involves the simultaneous application of high temperature (1350°C) and pressure (100 MPa) to induce a reaction between oxides of plutonium, calcium, titanium and zirconium, and other additives, to yield a material in which plutonium is dispersed at the atomic scale. The reaction takes place inside a sealed, evacuated stainless steel can, which also acts as the primary container for the waste package, see Figure 1. This approach has three key advantages: it is inherently a batch process and therefore accountancy of plutonium is assured at all times; the use of a sealed container eliminates the requirement for treatment of evolved gases; and the combined temperature and pressure ensure the processed waste is of minimum volume. In maturing hot isostatic pressing technology, we have developed, in collaboration, a unique furnace system suitable for processing radiological materials, which has been proven on a laboratory scale.

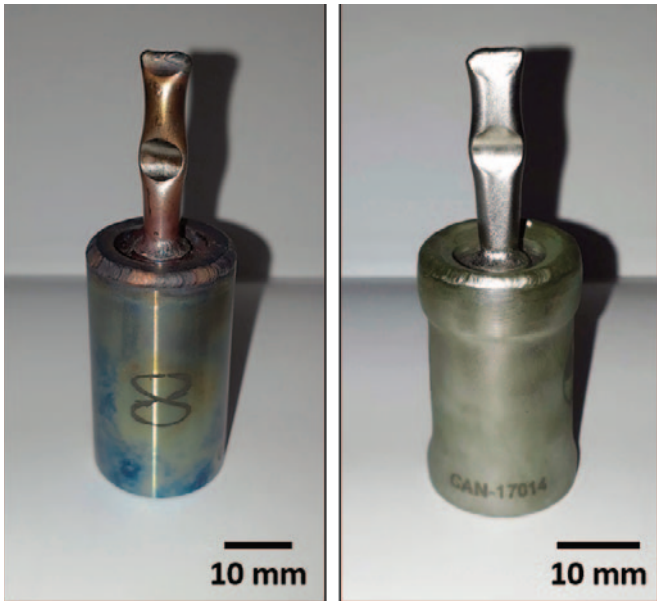


Figure 1: comparison of hot isostatically pressed ceramic waste forms pre- and post-processing (left and right), at development scale for radiological materials.

The outcome of this ongoing research will be the material formulation, process envelope, and technology maturation required to immobilise plutonium unsuitable for reuse as MOX fuel, and, if required, the totality of the separated stockpile. As an illustration of the efficacy of the approach, Figure 2 shows the microstructure of a glass-ceramic material designed to immobilise heavily contaminated plutonium residues using plutonium-239 at laboratory scale. The assemblage of zirconolite and accessory phases, encapsulated by a glass matrix which incorporates the chloride contaminants, exactly reproduces that achieved using uranium as a surrogate.

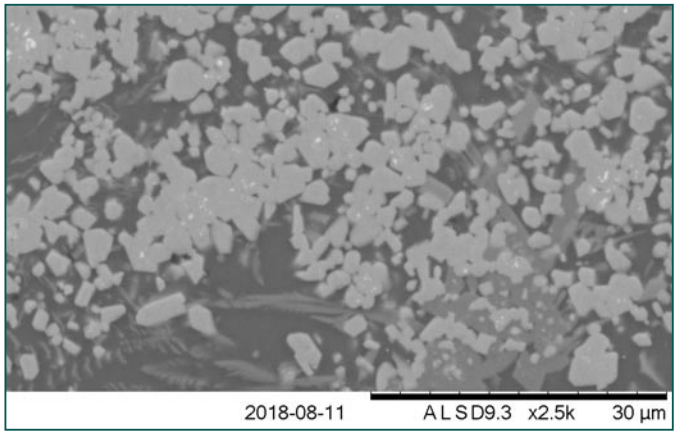


Figure 2: microstructure of glass-ceramic material for immobilisation of plutonium residues, showing light grey zirconolite crystallites encapsulated by a dark grey glass matrix.

Considerable progress has therefore been made in maturing immobilisation and disposal technology for plutonium disposition, to be confident in the efficacy of the approach, supported by evidence from the geological record for actinide retention in zirconolite and other mineral ceramic phases over deep time scales.

There is sufficient evidence from UK and international R&D programmes to have confidence that immobilisation and disposal of the plutonium stockpile is technically deliverable, but a considerable body of further research will be required for optimisation and implementation. Plutonium reuse as MOX fuel is considered a more mature technology (notwithstanding the aforementioned US and UK experience), however, the weak economic drivers and commercial interest in reusing plutonium as MOX fuel in light water reactors pose a fundamental challenge to the feasibility of current Government policy. Given that immobilisation and disposal will in any case be required to manage a significant fraction of the stockpile, it may now prove timely to revaluate plutonium management policy to adopt this approach for the totality of the UK stockpile.

DISINFORMATION ONLINE: SOCIAL MEDIA USER'S MOTIVATIONS FOR SHARING 'FAKE NEWS'

In line with the recommendation of the Digital, Culture, Media and Sport Committee (1), this article will use the term disinformation and not fake news.

William Dance, UKRI NWCDTP PhD Student and Associate Lecturer, Lancaster University

WHAT IS DISINFORMATION?

Disinformation is a global issue – it is language agnostic and can be published for political, social, financial or other gain. It can be seemingly innocuous without any apparent target or it can constitute abusive content directed at particular groups. Despite its prevalence and potential for harm, it is also often misunderstood. Disinformation is: *intentionally factually incorrect news that is published to deceive and misinform its reader.*

This is contrasted to misinformation – the unintentional sharing of false information. Usually disinformation is intentionally broadcast by the producer and misinformation is that same content unintentionally shared by the reader.

Disinformation differs from satire and parody because it endeavours to appear factual and sincere, though when poorly executed or hastily read, satire and parody may inadvertently be mistaken for truth. And though the concept – or its name – may feel new, it is a very old phenomenon. This can be shown by searching for terms such as *disinformation, misinformation* and *fake news* in large, historic databases of language. While the main terms used today are the three listed above, the most common term previously was *false news*:

Example	Year	Use
1	1534	that from henceforth none be so hardy to tell or publyshe any **false news** or saes whereby discord or ccsyon or dyscord or sklaunder may gw
2	1661	I. Innovations in Government ; Publishing of **false News**, and Prophesies ; Pretenses of Reformation ; Sects and Divisions in matters of Religion ; Quarrel against Episcopacy
3	1689	the King put out a Proclamation , prohibiting the spreading of Rumours and **False News.**

Disinformation has also been the subject of much discussion for over 300 years:

Example	Year	Use
4	2019	Why is there so much **"Fake News"** in this age of information
5	2017	Why make fake news up?
6	1692	What is the reason there is so much false news spread abroad, and that many delight to make others believe strange things?

The examples above show two tweets alongside writing from 1692, all posing the same question: why do people read and share disinformation? Some research has looked at political belief and the likelihood of sharing disinformation (2) while in the UK, Loughborough University's O3C research group administered a UK survey to answer these questions (3).

However, to understand why people share disinformation it is important to look at the precise moment it is shared: the point at which a reader becomes a sharer. By exploring this moment, we can identify the motives, rationales, and beliefs behind (unwittingly) sharing disinformation.

One exploratory method is to analyse social media posts that link to false content. Exploring what people write when they share false content can show *why* they shared it to begin with, and this is precisely what was done for section 3 of this article. For example:

In the example above, as in section 3 below, the yellow text is collected into a dataset, while the green information is not. This was done for a total of 10,743 tweets totalling 174,875 words. All the false articles linked to in these tweets were manually fact checked.

2. METHOD

To explore large quantities of naturally occurring language data like this, a method was needed that can process thousands of tweets (i.e. words) to produce coherent results. The method used was 'corpus linguistics'. From the Latin *corpus* (literally: body), corpus linguistics uses computers to explore linguistic patterns in large collections (or 'bodies') of language.

However, looking at single words or phrases may mean that some words are accidentally overlooked, thus an approach was chosen that grouped similar words – that is, words in the same semantic domain – together. A semantic domain can be as fundamental as 'words denoting science' or as fine grained as 'words denoting clothes and personal belongings'. The online tool, Wmatrix (4) developed at Lancaster University, was used to automatically assign semantic domains to words. Wmatrix draws on its USAS tag set, which contains 232 semantic categories (5) and this allowed similar words from the corpus to be grouped and analysed together.

3. WHY DO PEOPLE SHARE DISINFORMATION?

To investigate the characteristics of disinformation sharing, a larger non-disinformation dataset was collected. This corpus comprised shared news links irrespective of veracity and functioned as a benchmark. By comparing the two corpora (disinformation vs non-disinformation), the features that are unique to disinformation sharing can be revealed.

This method, known as keyness analysis, reveals items are that statistically significant, also known as statistically 'key'. This means the items occur beyond that of chance – for this study, the threshold was a less than one chance in a thousand of items being mislabelled as key ($p. < 0.0001$).

The most key semantic domain in the disinformation-sharing corpus was A10- Closed; Hiding/Hidden. This domain comprises terms relating to a level of concealment, and from the corpus the following instances occurred:

Uses
cover up; hiding; anon; classified; secret; burying; disappears; concealed; disguised; secret_society

The words all relate to information being hidden or secret, with uses such as *cover up* and *concealed*.

One possible explanation for these words appearing so often is that poverty of knowledge can contribute to falling victim to deception (6). In this sense, people rely on news to provide the knowledge they lack and stories that were *hidden* or *concealed* may be more enticing not only because they claim to provide new information, but because that information is supposedly being withheld, and must therefore be important. If one's goal is to obtain new information, it is logical to read articles that purport to contain exactly this. Similarly, allusions to *classified* and *cover up* can tap into and capitalise on distrust and conspiratorial belief.

Interestingly, the domain opposite to A10 - is also used unusually frequently in the disinformation sharing corpus. A10+ Open; Finding; Showing comprises terms relating to openness and exposure:

Uses
show; find; reveals; discovered; exposes; open; revealed; uncovers

By its very nature, disinformation is the revelation of fabricated "facts" previously unknown to anyone besides the author. As a result, those who believe and share that disinformation are likely to mention that it *reveals* and *exposes* and *uncovers*. Together, these two domains, A10- and A10+, show how people read and share disinformation because they view it as *exposing* and *revealing* news that is *secret* or *hidden*.

Another key domain is A5.2- Evaluation: False – words depicting (a lack of) truth:

Uses
lies; liars; disingenuous; nonsense; false; charade; deception; kidding; telling_lies; fabricated; misleading; fiction; crafty

This finding is not necessarily surprising. The prevalence of disinformation has been attributed to the notion of a post-truth society (7) and has been labelled as an "information crisis" (8). Similarly, research has noted that "the declining trust in mainstream media could be both a cause and a consequence of fake news gaining more traction" (Allcott and Gentzkow, 2017, p. 215). In this sense, low trust in institutions is compounded by disinformation which capitalises on this distrust. This is backed up by research that shows trust, both off and on social media, is decreasing in the global north (Reuters, 2018).

A similar domain that is key is O4.2- Negative Judgement of Appearance – these are terms relating to unpleasant general appearance and physical properties:

Uses
nasty; disgusting; vulgar; horrible; despicable; trashy; tasteless; vile; awful; tainted; soul-less

These uses show a clear sentiment: anger. That words denoting anger are statistically key in the sharing of disinformation shows that there is an important emotional element involved. A strong emotional response may well correlate with a reduced critical ability to spot falsehoods, thereby increasing the likelihood of unwittingly sharing false news – successful disinformation organisations are almost certainly aware of this.

However, anger and negative response are not the only emotions at play. The domain A13.3 Degree Boosters is also key. This domain comprises words such as intensifiers that amplify to a higher (but not the highest) degree:

Uses
really; more; very; so; such_a; far; extremely; as_hell; awfully; heavily; seriously; particularly

However, not all these terms are used negatively. Some uses in the data are:

Example	Use
7	Leave it to the trolls to stoop to this, and **much** worse
8	Something is **seriously** wrong with the #DOJ
9	Also a **very** good sign this is another false flag
10	David HOGG has been **astonishingly** articulate &; **highly** skilled at spreading a new narrative

The latter two uses above, *very good* and *astonishingly articulate*, exhibit a positive sentiment. This shows that these disinformation articles not only target emotion but are shared by people who are passionate and feel the need to use descriptors such as *very* and *really* much more commonly than non-disinformation news sharing. This is similar to the emotional investment seen with the negative judgements.

4. WHAT DOES ALL OF THIS MEAN?

A recurring theme in the examples above is truth. Whether this is social media users saying articles are *revealing* the truth or users accusing others of being *disingenuous* or *fake*, these results show that disinformation is an issue of truth. Further, declining trust creates the ideal conditions for disinformation which in turn creates a cycle of decreasing truth.

People are also passionate in their news sharing. Those sharing disinformation modify their posts with words like *extremely* and *very* more than those who share legitimate information. This suggests that our emotions potentially compromise our critical faculties, making us vulnerable to disinformation.

5. CONCLUSION: HOW WE TALK ABOUT DISINFORMATION MATTERS.

Disinformation is a multifaceted, complex issue. It is partly a media literacy issue, but it can also be caused, or exacerbated, by declining trust, socio-political beliefs, or an interplay of these and other factors. One aspect that is clear is that how we talk about disinformation matters.

Language is "socially constitutive as well as socially conditioned" (Fairclough and Wodak, 1997, p, 258) in that social situations can govern and be governed by the very language we use. The term 'fake news' itself is problematic due to its use as an insult, and although disinformation can be light-hearted such as with sensationalist clickbait, it also has the pernicious ability to damage social cohesion and target vulnerable groups.

How we discuss the issues of fake news, disinformation, and misinformation will determine how effective we can be in dealing with it and it should be treated as the far-reaching issue it is.

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FAKE NEWS – What it isn't, why it matters, and what to do about it

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TRUTH IS TRICKY.

For starters, it comes as little surprise that salacious, surprising, scary, titillating or disgusting falsity is much more exciting and engaging than banal (or even joyful, sad or trustworthy) truth. We can see concrete evidence of this in social media fora such as Twitter. A recent paper [1] in Science divides hundreds of thousands of tweets expressing claims that were fact checked into two categories: true and false. Next, they analyse how cascades of retweets differ for the two types of initial tweets. Their analysis shows that falsity spreads both further (reaching up to 100 times as many people) and faster (spreading to its audience between six and twenty times more swiftly). Though unsurprising, the result is maybe a bit disappointing: most of us just prefer to devour the stuff that is emotionally exciting over the more straight-laced truth.

But truth is tricky in another, deeper way, too. Since the end of the nineteenth century, we have been trained to think in terms of truth and falsity being a process of comparison: something is true if and only if the thing it denotes in the world is, in fact, in the world. By 'we' here I mean first of all philosophers, then those that have built upon their shoulders academically, and above all, mathematicians, linguists, computer scientists and latterly, those working in AI. But then from that basis in the universities, the intuitively appealing idea has spread by intellectual osmosis to all of us: it's obvious right? We should not ignore the philosophical intrigues of both the first half of the twentieth century, when many philosophers were trying to get to the bottom of the ramifications of this obvious idea; and then those of the second half of the twentieth century, when many other philosophers were trying to reject it completely. But neither of these help us very much in getting to grips with the fact that our obvious idea about truth and falsity is, at heart, wrong. It is, possibly, conceivably, arguably, not wrong for nice, clean, simple examples such as those that one might find in a textbook of philosophy or linguistics (the sentences, 'Snow is white,' 'The king of France is bald,' and 'What you bought yesterday you eat today,' for example, have kept the discipline well occupied for the best part of a century). But these are not the sort of things that real people ever actually say outside a philosophy or linguistics classroom.

Real people say things like this:

"Our trade with the EU has been declining rapidly over the last ten years as a share of our total trade. It's gone from about 55% to … about 44%."

And indeed, a real person did say this: Boris Johnson, then Foreign Secretary, made this claim during an interview on BBC Radio 4's *Today Programme* in February 2018. What is fascinating is that just an hour earlier on the same programme, Sir Martin Donnelly, former Permanent Secretary for the Department for International Trade, made a rather different claim. He said (and later repeated):

"Three fifths of our trade is with Europe."

So on the one hand we have a claim that 44% of trade is with the EU; on the other hand that the figure is 60%. It can't be both. So who's lying? Which of these Machiavellian orators is peddling falsity to us poor consumers of news? Which is the fake news? Well, surely we could just go check. Let's count up (or rather, let's refer to the work of the various analyses and reports from the Office of National Statistics and the details of the EU trade agreements) and then compare the statements with the reality; then we can put an approving green tick of truth next to one statement and a severe cross of falsity next to the other (and make a mental note perhaps not to trust that slimy devil in the future).

Of course actually going and checking those reports of the ONS, those details of the EU trade agreements, is a lot of work and not something that most of us would have the time or inclination to do. But luckily, we have a host of fact checking organisations who take on that work for us. In this case, we can turn to the BBC's Reality Check team who analysed these statements from the Today programme [2]. Their analysis is not at all surprising. It turns out that neither Donnelly nor Johnson were lying. Johnson was talking about exports of goods and services. Donnelly was talking about exports and imports, and was also factoring in trade relationships that existed because of the UK's agreement with the EU, including those covering trade with countries outside the EU.

So the truth of these two statements depends on how you define the word '*trade*' and even how you define the word '*with*' in this context. Though the connection to the world, the 'checking' of the reality is important, it is at least as important – more important even – to understand what is baked in to the things that are said. One can bake in particular definitions, as Johnson and Donnelly did here. By doing so they can each present reality in a particular light, with a particular slant, with a particular emphasis, that serves their agenda. But there are many things that can be baked in: an assumption about the time period over which we are talking (think:

'*global temperatures have actually dropped*'); an implicit judgmental orientation (think: *'the freedom fighters have liberated the city'*); or a statistical framing (think: *'a majority voted Yes in the referendum'*). In each case the same reality can be as accurately reported whilst supporting a different agenda – think, '*global temperatures have increased by 1.5 degrees over the past century*,' '*the terrorists have taken the city*,' '*37% of people voted Yes in the referendum*.'

One solution is to adopt a simple rating scale from more true to less true. This is the strategy adopted by Pulitzer prize winning fact checking website Politifact [3] which, using its 'Truth-O-Meter', rates claims from True through Mostly and Half True to Mostly False, False and Pants-on-Fire. But this misses the nuance, the subtlety and the sheer informativeness of the ways in which claims have different things baked in to them, and the enormous number of ways in which claims that are in conflict can be related.

We are just starting to investigate these relationships in AI research, with initial explorations of how these claims stand against one another being expressed as a tension that depends on subtle nuances of meaning or 'semantics' – so we're beginning to call the phenomenon *semantic tensioning*, and the complex networks of claims that constitute, for example, a news article or a set of news articles on a single topic from different media organisations a *tensioned network*. We know that these tensioned networks underpin a lot of disagreement, and we're starting to see how they interact with structures of news, biased news, fake news, and, perhaps most importantly, accusations of fake news.

One early application of this AI research has been the development of a software tool made available to schoolchildren in every secondary school in the UK called The Evidence Toolkit [4]. The idea is to process a news article with deep learning algorithms that aim to automatically identify the structure of the reasoning and at least some of the tensioned network, in order to help pupils automatically assess veracity. And it works: 9 in 10 said they were impressed and almost three quarters said it helped identify fake news.

There are two conclusions to draw, and one take-home message. First, these tensioned networks of claims are going to become extremely important in understanding and supporting society-scale discussion and engagement with news and democracy: but we need to do much more work to understand them. Second, fake news is not as simple as just checking the world to mark a claim with a tick or a cross. In almost every case, accusations of fake news, in particular, are about claims that are tensioned, not claims that are false.

Most importantly of all, the organisations that provide the investigative analysis – teams like Full Fact and like BBC Reality Check – have an increasingly important and high profile role to play. Though they bill themselves as 'fact checkers' – playing to our innate, simplistic and ultimately wrong view of truth and falsity – they do much more than just check: their detailed, sophisticated and nuanced analyses can help all of us understand how claims are tensioned and how we should make sense of them.

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2 https://www.bbc.co.uk/news/business-43212899

3 https://www.politifact.com/

4 https://www.bbc.co.uk/taster/pilots/evidence-toolkit-moral-maze

HOUSE OF COMMONS SELECT COMMITTEES

'This information was received prior to the dissolution of Parliament on the 6th November. We hope to feature details of the new Select Committees in the next issue of Science in Parliament'.

Current work and Inquiries

SCIENCE & TECHNOLOGY COMMITTEE

The Science and Technology Select Committee exists to ensure that Government policy and decision-making are based on good scientific and engineering advice and evidence. The Science and Technology Select Committee is unusual amongst departmental select committees in that it scrutinises the Government Office for Science (GO-Science), which is a "semiautonomous organisation" based within the Department for Business, Energy and Industrial Strategy. GO-Science "supports the Government Chief Scientific Adviser and works to ensure that Government policy and decision-making is underpinned by robust scientific evidence". The Committee therefore has a similarly broad remit and can examine the activities of departments where they have implications for, or made use of, science, engineering, technology and research. Norman Lamb was elected as Chair of the Science and Technology Committee on 12 July 2017. The Committee ceased to exist following the dissolution of Parliament on 6 November 2019 and will need to be set-up again in the new Parliament.

Contact: Science and Technology Committee House of Commons, London SW1A 0AA Telephone: 020 7219 2793 Email: scitechcom@parliament.uk.

RECENT CORRESPONDENCE includes

The work of the Science and Technology Committee

The Chair, Norman Lamb MP, wrote, on 31 October 2019, to the Science and Technology 'successor' Committee (which will be formed in the new Parliament). The letter provides an overview of work the Committee had publicly committed to undertake, including inquiries on commercial genomics, the impact of science funding policy on equality, diversity, inclusion and accessibility, and the role of science and technology in addressing challenges to food security and biodiversity.

Furthermore, it outlined areas in which the Committee had planned to undertake further work, including follow-up work on clinical trials transparency and evidence-based early years intervention.

Impact of science funding policy on equality, diversity, inclusion and accessibility

The Chair, Norman Lamb MP, wrote, on 9 September 2019, to the Chief Executive of UK Research and Innovation (UKRI). The letter sought information and data from UKRI to inform a future inquiry on the impact of science funding policy on equality, diversity, inclusion and accessibility. UKRI duly provided this information in correspondence, from UKRI Chief Executive Sir Mark Walport, on 30 October 2019.

RECENTLY CONCLUDED WORK includes

UK telecommunications infrastructure

Inquiry announced 7 June 2019. Oral evidence session took place 10 June 2019. The Chair, Norman Lamb MP, wrote on 10 July to the Secretary of State for Digital, Culture, Media and Sport, to conclude that, subject to various caveats, there were no technical grounds for excluding Huawei entirely from the UK's 5G or other telecoms networks. He urged the Government to publish the outcome of its Telecoms Supply Chain Review by the end of August. The Secretary of State replied to the Chair's letter on 6 September 2019 stating that the Telecoms Supply Chain Review was published 22 July 2019.

Commercial genomics

Inquiry announced 4 March 2019 into commercial genomic testing to establish what safeguards needed to be put in place to protect those who get tested following a successful pitch by the Nuffield Council on Bioethics as part of the Committee's 'My Science Inquiry' process. The Committee received over 80 pieces of written evidence and held two oral evidence sessions (15 and 28 October 2019). The Chair, Norman Lamb MP, wrote on 1 November 2019 to the Department of Health and Social Care with some initial issues arising from the inquiry. The letter highlighted concerns around the validity of genomic test results, the support available for consumers taking genomic tests, and the potential impact of direct-to-consumer testing on the NHS.

Due to the general election on 12 December 2019 the Committee has now closed this inquiry.

Work of the Science Minister and Government Chief Scientific Adviser

The Committee explored a range of topics with the Minister and his officials, including Horizon 2020, Horizon Europe, a future immigration system for science and research, and research funding. Oral evidence from the Minister, Chris Skidmore MP, was taken on 22 October 2019.

Evidence-based early-years intervention: follow-up

The Science and Technology Committee reported on its inquiry into *Evidence-based early years intervention* in October 2018 (Eleventh Report of Session 2017–19), exploring how intervening early in a child's life could reduce the long-term impact of negative experiences in later life. The Report recommended that the Government should make early intervention and childhood adversity a priority, and set out a clear national strategy. However, the Government's response by and large rejected the Report's recommendations. A second Report was therefore published (Fifteenth Report of Session 2017–19) commenting on the Government Response. This is still awaiting a Government response.

An evidence session with Ministers from the Departments of Education (DfE) and Health and Social Care (DHSC), as well as from the Ministry of Communities, Housing and Local Government (MCHLG), was scheduled to take place. However, due to the early Parliamentary General Election the Committee was unable to hold this follow-up session.

The Chair, Norman Lamb MP, wrote, on 31 October 2019, to the Secretaries of State for DfE, DHSC, MCHLG, Department for Work and Pensions and the Home Office, in addition to the Chief Secretary to the Treasury, asking for more clarity on this matter.

Clinical trials transparency: follow-up

The Science and Technology Committee held a one-off oral evidence session on 29 October 2019, as a follow-up to the Committee's Report on *Research integrity: clinical trials transparency*, which was published in October 2018. During the evidence session, the Committee heard from UK universities and English NHS Trusts, regarding the progress made towards full compliance with requirements to report clinical trials results. The Committee also discussed barriers to progress with representatives of the Health Research Authority, Medicines and Healthcare products Regulatory Agency and the British Medical Journal.

Following the session, the Chair, Norman Lamb MP, wrote, on 31 October 2019 to the European Medicines Agency and the Secretary of State for Health and Social Care, raising with them issues that were discussed at the evidence session.

RECENTLY CONCLUDED INQUIRIES include

22nd Report – Commercial and recreational drone use in the UK

Inquiry announced 7 March 2019. Report published 8 October 2019. Government Response awaited.

The Committee's Report concluded that, while drones offered the UK economy and society benefits and opportunities, it was vital that the Government ensured the risks were managed, investing in relevant research and technology to create a safe airspace. It recommended that the Government must set out a clear vision outlining the steps it and other agencies will take to do this, preferably in a White Paper no later than Summer 2020.

21st Report – Balance and effectiveness of research and innovation spending

Inquiry announced 20 July 2018. Report published 9 September 2019. Government Response awaited.

The Government set a target for research and development (R&D) funding to reach 2.4% of GDP by 2027. The Committee welcomed this target, recommending that the Department for Business, Energy and Industrial Strategy and UK Research and Innovation (UKRI) publish their 'roadmaps' setting out plans to achieve it as soon as possible. Furthermore, the Committee believed research excellence should be encouraged outside the 'golden triangle' (between London, Oxford and Cambridge) and recommended that UKRI significantly increased the size of the 'Strength in Places Fund' to address this issue.

20th Report – Clean Growth: Technologies for meeting the UK's emissions reduction targets

Inquiry announced 23 July 2018. Report published 17 July 2019. Government Response awaited.

The Committee welcomed the Government's decision to strengthen its long-term emissions reduction target, to effectively eliminate all emissions by 2050. Its Report, however, highlighted the lack of Government policies in place to meet this target and recommended a number of steps in different policy areas that should be taken to achieve net-zero emissions by 2050.

BUSINESS, ENERGY AND INDUSTRIAL STRATEGY

This Select Committee is appointed by the House of Commons to examine the administration, expenditure and policy of the Department for Business, Energy and Industrial Strategy (BEIS) and its associated public bodies. Contact: Business, Energy and Industrial Strategy Committee, House of Commons, London SW1A 0AA Telephone: 020 7219 5777 Email: beiscom@parliament.uk

CURRENT WORK includes

- **The safety of electrical goods in the UK follow-up**
  Inquiry announced on 2 July 2019
- **Future of Steel in the UK**
  Inquiry announced on 8 June 2019. Deadline for submissions 2 September
- **Supporting regional investment and growth**
  Inquiry announced on 5 April 2019. Oral evidence sessions taking place
- **Financing energy infrastructure**
  Inquiry announced on 27 February 2019.
- **Rolling out smart meters**
  Inquiry announced on 9 January 2019
- **Energy efficiency**
  Inquiry announced on 19 November 2018
- **Gas storage**
  Inquiry announced on 17 October 2018
- **Automation and the Future of Work**
  Inquiry announced on 24 May 2018
- **Clean Growth Strategy inquiry**
  Inquiry announced on 27 November 2018

REPORTS

2019 session:

- **2nd Report - The safety of electrical goods in the UK: follow-up**
- **1st Report – Future of the Post Office Network**

2017/19 session:

- **23rd Report – Automation and the future of work**
- **22nd Report – Pre-appointment hearing with the Government's preferred candidate for Chair of the Financial Reporting Council**

ENVIRONMENTAL AUDIT COMMITTEE

The remit of the Environmental Audit Select Committee is to consider the extent to which the policies and programmes of government departments and non-departmental public bodies contribute to environmental protection and sustainable development, and to audit their performance against sustainable development and environmental protection targets. Unlike most select committees, the Committee's remit cuts across government rather than focuses on the work of a particular department. is Contact: Environmental Audit Committee, House of Commons, London SW1A 0AA Telephone: 020 7219 5776 Email: eacom@parliament.uk

CURRENT WORK includes

- **Net zero government**
  Inquiry announced 04 July 2019 examining what the UK Government must do to align its own estate and activities with net zero emissions by 2050 or sooner. Accepting written submissions.
- **Electronic waste and the Circular Economy**
  Inquiry announced 27 June 2019 Accepting written submissions.
- **Invasive Species**
  Inquiry announced 04 April 2019 into the growing threat from invasive species Oral evidence sessions taking place.
- **Sustainability in the Department for Transport**
  Inquiry announced 28 March 2019 Oral evidence sessions taking place.
- **Voluntary National Review of UK progress against the Sustainable Development Goals**
  Inquiry announced 21 March 2019
- **Planetary Health**
  Inquiry announced 23 November 2018 into the risks relating to nutrition for UK and global human populations. Deadline for evidence passed.
- **Climate change and biodiversity**
  Inquiry announced 23 October 2017. No public meetings scheduled and no evidence published
- **Sustainable tourism**
  Inquiry announced 23 October 2017 into the environmental impact of travel and tourism No public meetings scheduled and no evidence published.

RECENT REPORTS

Invasive Species, published 25 October 2019

Scrutiny of the Environment Bill, 24 October 2019 (with accompanying correspondence which can be found on our website: https://www.parliament.uk/business/committees/committees-a-z/commons-select/environmental-audit-committee/publications/)

Our Planet, Our Health, published 17 September 2019

HEALTH & SOCIAL CARE COMMITTEE

The Health & Social Care Committee is appointed by the House of Commons to examine the policy, administration and expenditure of the Department of Health and its associated bodies The Committee chooses its own subjects of inquiry. Contact: Health Committee, House of Commons, London SW1A 0AA Telephone: 020 7219 6182 Email: healthcom@parliament.uk

COMMITTEE INQUIRIES

National Audit Office's Report on Investigation into pre-school vaccination Inquiry announced 25 October 2019

Health and Social Care Committee inquiry into National Audit Office's Report on Investigation into pre-school vaccination

NHS Capital Inquiry announced 23 October 2017

One-off evidence session to be held on Tuesday 22 October 2019

Childhood obesity follow-up 2019
Inquiry announced 16 September 2019

The inquiry was announced on Monday 16 September 2019

Dentistry Services Inquiry announced 31 July 2019

Health and Social Care Committee inquiry into Dentistry Services

Government's review of NHS overseas visitor charging
Inquiry announced 21 June 2019

Health and Social Care Committee inquiry into Government's review of NHS overseas visitor charging

NHS Long-term Plan: legislative proposals
Inquiry announced 01 March 2019

Health and Social Care Committee inquiry into NHS Long-term Plan: legislative proposals
Drugs policy Inquiry announced 04 February 2019

Health and Social Care Committee inquiry into Drugs policy
Drugs policy: medicinal cannabis
Inquiry announced 07 December 2018

Health and Social Care Committee inquiry into Drugs policy: medicinal cannabis
Availability of Orkambi on the NHS
Inquiry announced 30 November 2018

Health and Social Care Committee inquiry into Availability of Orkambi on the NHS
Budget and NHS long-term plan
Inquiry announced 15 November 2018

Health and Social Care Committee inquiry into effect of the Budget on health and social care
Work of NHS England and NHS Improvement
Inquiry announced 06 October 2017

Health and Social Care inquiry into the work of NHS England and NHS Improvement
Work of the Secretary of State for Health and Social Care
Inquiry announced 26 October 2017

Health and Social Care Committee inquiry into the work of Department for Health and Social Care
Calls for cases of GP visa issues
Inquiry announced 17 November 2017

Health and Social Care Committee inquiry into calls for cases of GP visa issues
Memorandum of understanding on data-sharing
Inquiry announced 09 January 2018

Health and Social Care Committee inquiry into Memorandum of understanding on data-sharing
Long term funding of adult social care
Inquiry announced 23 January 2018

Health and Social Care and Communities and Local Government Committees inquiry into the long term funding of adult social care
First 1000 days of life Inquiry announced 31 July 2018

Health and Social Care Committee
Inquiry into first 1000 days of life

Care Quality Commission's State of Care Report 2018-19
Inquiry announced 09 October 2019

Health and Social Care inquiry into Care Quality Commission's State of Care Report 2018-19

REPORT
- 1st Report - Drugs policy | PDF version 1st Report - Drugs policy (pdf PDF) Opens in a new window HC 143 | Published 23 October 2019

HOUSE OF LORDS SELECT COMMITTEES

The Committees ceased to exist following the dissolution of Parliament on 6 November 2019 and will need to be set-up again in the new Parliament.

SCIENCE AND TECHNOLOGY COMMITTEE

The Science and Technology Committee has a broad remit "to consider science and technology". It scrutinises Government policy by undertaking cross-departmental inquiries into a range of different activities. These include:

- public policy areas which ought to be informed by scientific research (for example, health effects of air travel),
- technological challenges and opportunities (for example, genomic medicine) and
- public policy towards science itself (for example, setting priorities for publicly funded research).

In addition, the Committee undertakes from time to time shorter inquiries, either taking evidence from Ministers and officials on topical issues, or following up previous work.

EU ENERGY AND ENVIRONMENT SUB-COMMITTEE

The Sub-Committee focuses on a range of policy areas related to agriculture, fisheries, environment and energy. Attention is given to agricultural issues, particularly legislation relating to the Common Agricultural Policy (CAP) and animal health and welfare issues. The Common Fisheries Policy (CFP) and wider environmental issues are also examined, as are policies relating to energy and climate change.

FOOD, POVERTY, HEALTH AND THE ENVIRONMENT SELECT COMMITTEE

This was appointed on 13 June 2019. Its inquiry into the links between inequality, health inequalities and food sustainability was announced on 24 July.

PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY (POST)

POST is a bicameral body that bridges research and policy, providing reliable and up-to-date research evidence for the UK Parliament. It is overseen by a Board of MPs, Peers and external experts.

POST briefings are impartial, non-partisan, and peer-reviewed. Timely and forward thinking, they are designed to make scientific research accessible to the UK Parliament

POSTnotes are four-page summaries of public policy issues based on reviews of the research literature and interviews with stakeholders from across academia, industry, government and the third sector. They are peer reviewed by external experts.

POSTnotes are often produced proactively, so that parliamentarians have advance knowledge of key issues before they reach the top of the political agenda.

Those produced so far in 2019 are:

609: Access to Critical Materials

608: Online Safety Education

607: Improving Witness Testimony

606: Compostable Food Packaging

605: Plastic Food Packaging Waste

604: Climate Change and Fisheries

603: Climate Change and UK Wildfire

602: Developments in Wind Power

601: Sustaining the Soil Microbiome

600: Climate Change and Agriculture

599: Early Interventions to Reduce Violent Crime

598: Advances in Cancer Treatment

597: Climate Change & Vector-Borne Disease in Humans in the UK

596: Chemical Weapons

595: Reservoirs of Antimicrobial Resistance

594: Limiting Global Warming to 1.5°C

593: Cyber Security of Consumer Devices

Ongoing and future projects approved by the POST Board.

BIOLOGY AND HEALTH

In production

Autism update
Causes of obesity
Outward medical tourism
Regulating germline therapies

Scheduled

3D printing in medicine
Blockchain technology in the food chain
Industry influence on public health policy
Resilient food supply chains
Researching gambling
Screen time in young people

ENERGY AND ENVIRONMENT

In production

Climate change and aviation
Food waste
Global deal for nature
Heat networks
Insect population decline

Scheduled

Bioenergy and carbon capture and storage
Plant genetic resources for food and agriculture
Sustainable cooling

PHYSICAL SCIENCES AND ICT

In production

Algorithms and accountability
Civilian drones
New computing technologies

Scheduled

Infrastructure and climate change
Key EU space programmes

SOCIAL SCIENCES

In production

Integrating health and social care
Non-custodial sentencing
Research glossary

Scheduled

Online extremism

POSTbriefs are responsive policy briefings based on mini-literature reviews and peer reviews. Those produced so far on 2019 are

- 34: Net Gain
- 33: Research for Parliament: Preparing for a changing world
- 32: 5G technology
- 31: Evaluating UK natural hazards: the national risk assessment

The POST Board oversees POST's objectives, outputs and future work programme. It meets quarterly.

Officers

- Chair: Adam Afriyie MP
- Vice-Chair: Professor the Lord Winston, FmedSci, FRSA, FRCP, FRCOG, FREng
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- Professor Sir Bernard Silverman, FRS, FAcSS
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- Dr Grant Hill-Cawthorne, Head of the Parliamentary Office of Science and Technology
- Penny Young, House of Commons Librarian and Managing Director of Research & Information
- James Rhys, Principal Clerk, Committee Office, House of Commons
- Edward Potton, Head of Science and Environment Section, House of Commons Library
- Nicolas Besly, Clerk of Select Committees, House of Lords

Head of POST

- Dr Grant Hill-Cawthorne: 020 7219 2952

PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY

Houses of Parliament
Westminster
London SW1A 0AA

HOUSE OF COMMONS LIBRARY

The House of Commons Library is an independent research and information unit. It provides impartial information for Members of Parliament of all parties and their staff. This service supports MPs in their work scrutinising Government, proposing legislation, and supporting constituents.

The Library provides confidential, impartial and bespoke briefing to Members of the House of Commons and their offices on a daily basis supporting the full range of parliamentary work, from policy development to constituency issues.

One of the main products the Commons Library produces is research briefings. These provide in-depth and impartial analysis of all major pieces of legislation. The briefings also cover areas of policy, frequently asked questions and topical issues. These research briefings are published online and are available to MPs and the general public. You can also find the research briefings on the Commons Library website (https://commonslibrary.parliament.uk) where you can also sign up for personalised alerts for new or updated briefings in subject areas.

The Library has produced many research briefings around the debate on Brexit. These include:

The October 2019 EU UK Withdrawal Agreement

Published Friday, October 18, 2019 CBP-8713

Revisions to the Political Declaration on the framework for future EU-UK relations

Published Friday, October 18, 2019 CBP-8714

Planning for a no-deal Brexit

Published Tuesday, November 5, 2019 CBP-8733

The Science and Environment Section (SES) is one of eight teams in the Research Service in the House of Commons Library. In 2019 they have published, and continue to update, briefings on issues varied as:

Environment Bill 2019-2020

Published Thursday, October 24, 2019 CBP-8712; published for second reading on 28 October 2019.

Energy Smart Meters

Published Monday, October 7, 2019 CBP-8119; covering issues around the rollout of energy 'smart meters' to 30 million homes and smaller non-domestic sites in Great Britain.

New Nuclear Power

Published Wednesday, September 25, 2019 CBP-8176; summarising current progress on nuclear power, including conventional reactors, advanced designs, waste disposal, and nuclear research.

5G

Published Friday, September 6, 2019 CBP-7883; included is an explanation of 5G and its expected uses; policy challenges associated with 5G and information about the roll-out of 5G in the UK including forthcoming spectrum auctions.

Brexit: energy and climate change

Published Thursday, September 5, 2019 CBP-8394; this discusses key energy and climate change policy in the UK, the status of related Brexit negotiations and the possible impact of Brexit on these policy areas, including in relation to a no deal scenario.

UK Carbon Budgets

Published Tuesday, July 9, 2019 CBP-7555; this includes information on the Climate Change Act 2008, the Committee on Climate Change's proposals for the fifth carbon budget, the Government's Clean Growth Strategy and progress against carbon budgets. Information on the Paris Agreement and possible impact of Brexit is also included.

Legislating for net zero

Published Thursday, June 27, 2019 CBP-8590; this provides an explanation of the introduction of the UK's net zero by 2050 target. It provides the context for the emissions reduction target and a brief overview of relevant commentary and analysis of the Government's proposals.

Electric vehicles and infrastructure

Published Friday, June 28, 2019 CBP-7480; this explains what electric vehicles are and how successive governments have planned for infrastructure and provided vehicle grants and incentives to encourage and accommodate their growth. It also sets out how the electricity grid is preparing to accommodate any increased demand from EV charging and looks at comparative emissions from EVs and conventional vehicles.

UK Research and Innovation

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Website: www.ukri.org

Big challenges demand big thinkers - those who can unlock the answers and further our understanding of the important issues of our time. Our work encompasses everything from the physical, biological and social sciences, to innovation, engineering, medicine, the environment and the cultural impact of the arts and humanities. In all of these areas, our role is to bring together the people who can innovate and change the world for the better. We work with the government to invest over £7 billion a year in research and innovation by partnering with academia and industry to make the impossible, possible. Through the UK's nine leading academic and industrial funding councils, we create knowledge with impact.

Arts and Humanities Research Council

Website: www.ahrc.ukri.org

AHRC funds outstanding original research across the whole range of the arts and humanities. This research provides economic, social and cultural benefits to the UK, and contributes to the culture and welfare of societies around the globe.

Biotechnology and Biological Sciences Research Council

Website: www.bbsrc.ukri.org

BBSRC invests in world-class bioscience research and training. This research is helping society to meet major challenges, including food security, green energy and healthier, longer lives and underpinning important UK economic sectors, such as farming, food, industrial biotechnology and pharmaceuticals.

Economic and Social Research Council

Website: www.esrc.ukri.org

ESRC is the UK's largest funder of research on the social and economic questions facing us today. This research shapes public policy and contributes to making the economy more competitive, as well as giving people a better understanding of 21st century society.

Engineering and Physical Sciences Research Council

Website: www.epsrc.ukri.org

EPSRC invests in world-leading research and postgraduate training across the engineering and physical sciences. This research builds the knowledge and skills base needed to address scientific and technological challenges and provides a platform for future UK prosperity by contributing to a healthy, connected, resilient, productive nation.

Innovate UK

Website: www.gov.uk/government/organisations/innovate-uk

Innovate UK drives productivity and economic growth by supporting businesses to develop and realise the potential of new ideas, including those from the UK's world-class research base. They connect businesses to the partners, customers and investors that can help them turn these ideas into commercially successful products and services, and business growth.

Medical Research Council

Website: www.mrc.ukri.org

MRC is at the forefront of scientific discovery to improve human health. Its scientists tackle some of the greatest health problems facing humanity in the 21st century, from the rising tide of chronic diseases associated with ageing to the threats posed by rapidly mutating micro-organisms.

Natural Environment Research Council

Website: www.nerc.ukri.org

NERC is the driving force of investment in environmental science. Its leading research, skills and infrastructure help solve major issues and bring benefits to the UK, such as affordable clean energy, air pollution, and resilience of our infrastructure.

Research England

Website: www.re.ukri.org

Research England creates and sustains the conditions for a healthy and dynamic research and knowledge exchange system in English universities. Working to understand their strategies, capabilities and capacity; supporting and challenging universities to create new knowledge, strengthen the economy, and enrich society.

Science and Technology Facilities Council

Website: www.stfc.ukri.org

STFC is a world-leading multi-disciplinary science organisation. Its research seeks to understand the Universe from the largest astronomical scales to the tiniest constituents of matter, and creates impact on a very tangible, human scale.

Association of the British Pharmaceutical Industry

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The Association of the British Pharmaceutical Industry (ABPI) represents innovative research-based biopharmaceutical companies, large, medium and small, leading an exciting new era of biosciences in the UK. Our industry, a major contributor to the economy of the UK, brings life-saving and life-enhancing medicines to patients. Our members are researching and developing over two-thirds of the current medicines pipeline, ensuring that the UK remains at the forefront of helping patients prevent and overcome diseases. Topics we focus on include:

- All aspects of the research and development of medicines including clinical research and licensing
- Stratified medicine
- Vaccines, biosimilars, small and large molecules, cell therapy and regenerative medicine

airto

driving growth and innovation

Contact: Dr Jane Gate, Executive Director
AIRTO Ltd: Association of Innovation
Research & Technology Organisations Ltd
c/o National Physical Laboratory
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E-mail: enquiries@airto.co.uk
Twitter: @airtoinnovation
Website: www.airto.co.uk

AIRTO, the Association of Innovation, Research and Technology Organisations, comprises approximately sixty principal organisations operating in the UK's Innovation, Research and Technology (IRT) sector. The IRT sector has a combined turnover of £6.9Bn, employs over 57,000 people and contributes £34Bn to UK GVA. AIRTO's members work at the interface between academia and industry, for both private and public sector clients. Members include independent Research and Technology Organisations, Catapult Centres, Public Sector Research Establishments, National Laboratories, some university Technology Transfer Offices and some privately held innovation companies.

AMPS The Association of Management and Professional Staffs.

Contact:
Tony Harding
07895 162 896 for all queries whether for membership or assistance.
Branch Office Address:
Merchant Quay,
Salford Quays, Salford
M50 3SG.

Website: www.amps-tradeunion.com

We are a Trades Union for Management and Professional Staff working in the pharmaceutical, chemical and allied industries.

We have produced a training programme funded by the EU on diversity and helping women managers remain in the workplace after a career break. This training programme is aimed at both men and women and is intended to address the shortfall in qualified personnel in the chemical and allied industries.

We are experts in performance based and field related issues and are affiliated to our counterparts in EU Professional Management Unions.

AWE

Contact:
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AWE plays a crucial role in our nation's defence by providing and maintaining warheads for the UK's nuclear deterrent and delivers advice and guidance on a 24/7 basis to UK government in the area of national security.

We are a centre of scientific, engineering and technological excellence, with some of the most advanced research, design and production facilities in the world. AWE is contracted to the Ministry of Defence (MOD) through a Government-owned-contractor-operated (GOCO) arrangement. While our sites and facilities remain in government ownership, their management, day-to-day operations and maintenance of Britain's nuclear stockpile is contracted to a private company: AWE Management Limited (AWE ML). AWE ML is a consortium comprising three partners: Jacobs Engineering Group, the Lockheed Martin Corporation and Serco Group plc.

BIOCHEMICAL SOCIETY

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The Biochemical Society works to promote the molecular biosciences; facilitating the sharing of expertise, supporting the advancement of biochemistry and molecular biology and raising awareness of their importance in addressing societal grand challenges. We achieve our mission by :

- bringing together molecular bioscientists;
- supporting the next generation of biochemists;
- promoting and sharing knowledge and
- promoting the importance of our discipline.

British Antarctic Survey

NATURAL ENVIRONMENT RESEARCH COUNCIL

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British Antarctic Survey (BAS), an institute of NERC, delivers and enables world-leading interdisciplinary research in the Polar Regions. Its skilled science and support staff based in Cambridge, Antarctica and the Arctic, work together to deliver research that uses the Polar Regions to advance our understanding of Earth as a sustainable planet. Through its extensive logistic capability and know-how BAS facilitates access for the British and international science community to the UK polar research operation. Numerous national and international collaborations, combined with an excellent infrastructure help sustain a world leading position for the UK in Antarctic affairs. For more information visit www.bas.ac.uk @basnews

BRITISH ECOLOGICAL SOCIETY

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Twitter: @BESPolicy

The British Ecological Society is an independent, authoritative learned society, and the voice of the UK's ecological community. Working with our members we gather and communicate the best available ecological evidence to inform decision making. We offer a source of unbiased, objective ecological knowledge, and promote an evidence-informed approach to finding the right solutions to environmental questions.

British In Vitro Diagnostics Association (BIVDA)

BIVDA

Contact: Doris-Ann Williams MBE
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BIVDA is the UK industry association representing companies who manufacture and/or distribute the diagnostics tests and equipment to diagnose, monitor and manage disease largely through the NHS pathology services. Increasingly diagnostics are used outside the laboratory in community settings and also to identify those patients who would benefit from specific drug treatment particularly for cancer.

BRITISH PHARMACOLOGICAL SOCIETY

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The British Pharmacological Society is a charity with a mission to promote and advance the whole spectrum of pharmacology. It is the primary UK learned society concerned with drugs and the way they work, and leads the way in the research and application of pharmacology around the world.

Founded in 1931, the Society champions pharmacology in all its forms, across academia, industry, regulatory agencies and the health service. With over 3,500 members from over 60 countries worldwide, the Society is a friendly and collaborative community. Enquiries about the discovery, development and application of drugs are welcome.

Tracey Guise, Chief Executive Officer
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BSAC is a learned society whose members are among the world's leading infectious disease physicians, pharmacists, microbiologists, and nurses.

With more than 45 years of leadership in antibiotic research and education, BSAC is dedicated to saving lives by fighting infection. It does this by supporting a global network of experts via workshops, conferences, evidence-based guidelines, e-learning courses, and its own high-impact international journal.

BSAC also provides national surveillance and susceptibility testing programmes, an outpatient parenteral antimicrobial therapy (OPAT) initiative, research and development grants, and the secretariat for the All-Party Parliamentary Group on Antibiotics.

BSAC has members in 40 nations and active learners in more than 135 countries.

Contact Dr Doug Brown, CEO
British Society for Immunology
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E-mail: bis@immunology.org
Website: www.immunology.org

The British Society for Immunology's mission is to promote excellence in immunological research, scholarship and clinical practice in order to improve human and animal health. We are the leading UK membership organisation working with scientists and clinicians from academia and industry to forward immunology research and application around the world. Our friendly, accessible community of over 3,500 immunologists gives us a powerful voice to advocate for immunological science and health for the benefit of society.

Contact: Ian Brown
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Cranfield
Bedfordshire
United Kingdom

The British Society of Soil Science (BSSS) or "BS cubed" as it is fondly known was founded in 1947 by a number of eminent British soil scientists. It was formed with the aims: to advance the study of soil; to be open to membership from all those with an interest in the study and uses of soil; and to issue an annual publication.

Nowadays BSSS is an established international membership organisation and charity committed to the study of soil in its widest aspects. The Society acts as a forum for the exchange of ideas and provides a framework for representing the views of soil scientists to other organisations and decision making bodies. It promotes research by organising several conferences each year and by the publication of its two scientific journals, the European Journal of Soil Science, and Soil Use and Management.

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Brunel University London is an international research active university with 3 leading research institutes:

Institute of Energy Futures: Led by Professor Savvas Tassou, the main themes of the Institute are *Advanced Engines and Biofuels, Energy Efficient and Sustainable Technologies, Smart Power Networks*, and *Resource Efficient Future Cities*.

Institute of Materials and Manufacturing: The main themes of research are *Design for Sustainable Manufacturing, Liquid Metal Engineering, Materials Characterisation and Processing, Micro-Nano Manufacturing*, and *Structural Integrity*. The Institute is led by Professor Luiz Wrobel.

Institute of Environment, Health and Societies: Professor Susan Jobling leads this pioneering research institute whose themes are *Health and Environment, Healthy Ageing, Health Economics Synthetic Biology, Biomedical Engineering and Healthcare Technologies*, and *Social Sciences and Health*.

Brunel University London offers a wide range of expertise and knowledge, and prides itself on having academic excellence at the core of its offer, and was ranked in the recent REF as 33rd in the UK for Research Power (average quality rating by number of submissions) and described by The Times Higher Education as one of the real winners of the REF 2014.

Cavendish Laboratory

UNIVERSITY OF CAMBRIDGE

Contact: Departmental Administrator,
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J J Thomson Avenue, Cambridge CB3 0HE, UK.
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http://www.phy.cam.ac.uk

The Cavendish Laboratory houses the Department of Physics of the University of Cambridge.

The research programme covers the breadth of contemporary physics

Extreme Universe: Astrophysics, cosmology and high energy physics

Quantum Universe: Cold atoms, condensed matter theory, scientific computing, quantum matter and semiconductor physics

Materials Universe: Optoelectronics, nanophotonics, detector physics, thin film magnetism, surface physics and the Winton programme for the physics of sustainability

Biological Universe: Physics of medicine, biological systems and soft matter

The Laboratory has world-wide collaborations with other universities and industry

Chartered Institute of Ergonomics & Human Factors

Stephen Barraclough
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www.ergonomics.org.uk

Ergonomics, also called Human Factors, sometimes abbreviated 'E/HF' is a science-based discipline about 'designing for people'. E/HF takes into account the physical and mental capabilities, aptitudes and abilities of people acting individually (a pilot, a surgeon or nurse, train driver) or collectively, with or without equipment (a theatre team, air traffic control) in the design of workplaces, equipment and ways of working to deliver the least harmful, safest, most efficient, most elegant possible outcomes'. E/HF uses science to improve the places in which we work, live and relax and the ways in which we interact with people, equipment and systems.

The Cosmetic Toiletry & Perfumery Association | ctpa

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Website: www.ctpa.org.uk &
www.thefactsabout.co.uk

CTPA is the UK trade association representing manufacturers of cosmetic products and suppliers to the cosmetic products industry. 'Cosmetic products' are legally defined and subject to stringent EU safety laws. CTPA is the authoritative public voice of a vibrant and responsible UK industry trusted to act for the consumer; ensuring the science behind cosmetics is fully understood.

CLIFTON SCIENTIFIC Trust

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E-mail: eric.albone@clifton-scientific.org
Website: www.clifton-scientific.org

Science for Real- Science for Life-Science for Citizenship and Employability

We build grass-roots partnerships between school and the wider world of professional science and engineering

- encountering science as a creative, questioning, collaborative human activity
- bringing school science added meaning and motivation, from primary to post-16
- locally, nationally, internationally (our UK-Japan Young Scientist Workshop Programme in since 2001)

Clifton Scientific Trust Ltd is registered charity 1086933

The Council for the Mathematical Sciences

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Website: www.cms.ac.uk

The Council for the Mathematical Sciences is an authoritative and objective body that works to develop, influence and respond to UK policy issues affecting mathematical sciences in higher education and research, and therefore the UK economy and society by:

- providing expert advice;
- engaging with government, funding agencies and other decision makers;
- raising public awareness; and
- facilitating communication between the mathematical sciences community and other stakeholders

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The Francis Crick Institute is a biomedical discovery institute dedicated to understanding the fundamental biology underlying health and disease. Its work is helping to understand why disease develops and to translate discoveries into new ways to prevent, diagnose and treat illnesses such as cancer, heart disease, stroke, infections, and neurodegenerative diseases.

The Crick was formed in 2015, and in 2016 it moved into a brand new state-of-the-art building in central London which brings together 1500 scientists and support staff working collaboratively across disciplines.

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Founded in 1992 in memory of the UK's first female Professor of Physics, the Trust is the UK's leading charity dedicated to realising the potential of scientists and engineers returning to research after career breaks for family, caring and health reasons. Our Fellowship programme, working in partnership with universities, research councils, charities, learned societies and industry, enables individuals to undertake part-time research in universities and research institutes. Fellowships comprise a research project alongside an individually tailored retraining programme, with additional mentoring and support, enabling recipients to re-establish scientific credentials, update skills and redevelop confidence, in a suitably supportive environment.

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The Energy Institute (EI) is the chartered professional membership body bringing global energy expertise together. Our ambition is that energy, and its critical role in our world, is better understood, managed and valued. We're a unique network with insight spanning the world of energy, from conventional oil and gas to the most innovative renewable and energy efficient technologies. We gather and share essential knowledge about energy, the skills that are helping us all use it more wisely, and the good practice needed to keep it safe and secure. We articulate the voice of energy experts, taking the know-how of around 20,000 members and 250 companies from 120 countries to the heart of the public debate. And we're an independent, not-for-profit, safe space for evidence-based collaboration, an honest broker between industry, academia and policy makers.

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EngineeringUK is an independent organisation that promotes the vital role of engineers, engineering and technology in our society. EngineeringUK partners business and industry, Government and the wider science and technology community: producing evidence on the state of engineering; sharing knowledge within engineering, and inspiring young people to choose a career in engineering, matching employers' demand for skills.

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Fera provides expert analytical and professional services to governments, agrichemical companies, food retailers, manufacturers and farmers to facilitate safety, productivity and quality across the agrifood supply chain in a sustainable and environmentally compatible way.

Fera uses its world leading scientific expertise to provide robust evidence, rigorous analysis and professional advice to governments, international bodies and companies worldwide. Our food integrity, plant health, agri-tech and agri-informatics services ensure that our customers have access to leading edge science, technology and expertise.

First Group

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FirstGroup are the leading transport operator in the UK and North America and each day, every one of our 110,000 employees works hard to deliver vitally important services for our passengers. During the last year around 2.2 billion passengers relied on us to get to work, to school or college, to visit family and friends, and much more.

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GAMBICA is the voice of the laboratory technology, instrumentation, control and automation industries, providing influence, knowledge and community. We offer members a common platform for voicing their opinions and representing their common interests to a range of stakeholders. GAMBICA seeks to spread best-practice and be thought leaders in our sectors.

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The Geological Society is the national learned and professional body for Earth sciences, with 12,000 Fellows (members) worldwide. The Fellowship encompasses those working in industry, academia and government, with a wide range of perspectives and views on policy-relevant science, and the Society is a leading communicator of this science to government bodies and other non-technical audiences.

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Advancing knowledge and setting standards in biomedical science

With over 20,000 members in over 30 countries, the Institute of Biomedical Science is the leading professional body for biomedical scientists, support staff and students.

For over 100 years we have been dedicated to the promotion, development and delivery of excellence in biomedical science within all aspects of healthcare, and providing the highest standards of service to patients and the public.By supporting our members in their practice of biomedical science we set quality standards for the profession through: training, education, assessments, examinations and continuous professional development.

Institute of Food Science + Technology

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IFST is the independent qualifying body for food professionals in Europe. Membership is drawn from all over the world from backgrounds including industry, universities, government, research and development and food law enforcement.

IFST's activities focus on disseminating knowledge relating to food science and technology and promoting its application. Another important element of our work is to promote and uphold standards amongst food professionals.

IKE Institute of Innovation & Knowledge Exchange

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IKE is the UK's professional body for innovators. It accredits and certificates innovation practices. We influence the inter-relationship between education, business, and government through research and collaborative networks. Our Innovation Manifesto highlights our commitment to support the development of innovative people and organisations. IKE runs think-tanks, conducts research, develops new business models and tools and supports organisations to benchmark their innovation capabilities.

Institute of Marine Engineering, Science and Technology (IMarEST)

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Established in London in 1889, the IMarEST is a leading international membership body and learned society for marine professionals, with over 15,000 members worldwide. The IMarEST has an extensive marine network of 50 international branches, affiliations with major marine societies around the world, representation on the key marine technical committees and non-governmental status at the International Maritime Organization (IMO) as well as other intergovernmental organisations.

The Institute of Materials Finishing

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The Institute of Materials Finishing is the premier technical organisation representing industry, academia and individual professionals in both the UK's and global surface engineering and materials finishing sector.
We actively promote continual education and knowledge dissemination by providing both distance learning and tutored training courses, as well as a technical support service. We also provide bespoke courses that are tailored to an employer's specific needs. The Institute also publishes *Transactions of the Institute of Materials Finishing* and a bimonthly newsletter (*IMFormation*), as well as holding regular regional and international technical meetings, symposia and conferences.

Institute of Measurement and Control

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The Institute of Measurement and Control is a professional engineering institution and learned society dedicated to the science and application of measurement and control technology for the public benefit. The InstMC has a comprehensive range of membership grades for individuals engaged in both technical and non-technical occupations. Also, it is licensed by the Engineering Council to assess and register individuals as Chartered Engineers (CEng), Incorporated Engineers (IEng) and Engineering Technicians (EngTech).

The InstMC works to develop the knowledge and skills of individual engineers, fostering communication and advancing the science and practices within the industry.

IOP Institute of Physics

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The Institute of Physics is the professional body for physics in the UK and Ireland, inspiring people to develop their understanding and enjoyment of physics. We are a world-leading science publisher and proud to be a trusted voice for the physics community.

Our work includes supporting the teaching of physics, encouraging innovation in business and providing evidence-based advice to Government. Our members are from across the physics community – in academia, the classroom, and industry – and our reach extends to all who have an interest in physics and its contribution our culture, society and economy.

IPEM Institute of Physics and Engineering in Medicine

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IPEM is a registered, incorporated charity for the advancement, in the public interest, of physics and engineering applied to medicine and biology. Its members are medical physicists, clinical and bio-engineers, and clinical technologists. It organises training and CPD for them, and provides opportunities for the dissemination of knowledge through publications and scientific meetings. IPEM is licensed by the Science Council to award CSci, RSci and RSciTech, and by the Engineering Council to award CEng, IEng and EngTech.

IChemE Advancing Chemical Engineering Worldwide

The Institution of Chemical Engineers

With over 44,000 members in 120 countries, IChemE is the global membership organisation for chemical engineers. A not for profit organisation, we serve the public interest by building and sustaining an active professional community and promoting the development, understanding and application of chemical engineering worldwide.

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IET The Institution of Engineering and Technology

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The IET is a world leading professional organisation, sharing and advancing knowledge to promote science, engineering and technology across the world. Dating back to 1871, the IET has over 163,000 members in 127 countries with offices in Europe, North America, and Asia-Pacific.

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LGC is an international leader in the extended life sciences sector, providing reference materials, genomics reagents and instrumentation, as well as research and measurement services, to customers in the public and private sectors.

Under the Government Chemist function, LGC fulfils specific statutory duties as the referee analyst and provides advice for Government and the wider analytical community on the implications of analytical measurement for matters of policy, standards and regulation. LGC is also the UK's National Measurement Laboratory for chemical and bio-measurement.

With headquarters in Teddington, South West London, LGC has 46 laboratories and centres across Europe and at sites in China, Brazil, India, South Africa and the US.

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L'Oréal employs more than 3,800 researchers world-wide and dedicates over €877 million each year to research and innovation in the field of healthy skin and hair. The company supports women in science research through the L'Oréal UNESCO For Women In Science Programme and engages young people with science through the L'Oréal Young Scientist Centre at the Royal Institution. L'Oréal also collaborates with a vast number of institutions in the UK and globally.

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As the world's oldest active biological society, the Linnean Society is an essential forum and meeting point for those interested in the natural world. The Society holds regular public lectures and events, publishes three peer-reviewed journals, and promotes the study of the natural world with several educational initiatives. The Society is home to a world famous library and collection of natural history specimens. The Society's Fellows have a considerable range of biological expertise that can be harnessed to inform and advise on scientific and public policy issues.

A Forum for Natural History

London School of Hygiene & Tropical Medicine
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The London School of Hygiene & Tropical Medicine (LSHTM) is a world-leading centre for research and postgraduate education in public and global health with over 4,000 students and more than 1,300 staff working in over 100 countries across the world – including at two MRC Units in The Gambia and Uganda which joined LSHTM in 2018. Our depth and breadth of expertise encompasses many disciplines, and we are one of the highest-rated research institutions in the UK.

Marine Biological Association

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Since 1884 the Marine Biological Association has been delivering its mission *'to promote scientific research into all aspects of life in the sea, including the environment on which it depends, and to disseminate to the public the knowledge gained.'* The MBA represents its members in providing a clear independent voice to government on behalf of the marine biological community. It also has an extensive research programme and a long history as an expert provider of advice for the benefit of policy makers and wider society.

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The Institution provides politicians and civil servants with information, expertise and advice on a diverse range of subjects, focusing on manufacturing, energy, environment, transport and education policy. We regularly publish policy statements and host political briefings and policy events to establish a working relationship between the engineering profession and parliament.

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The Met Office doesn't just forecast the weather on television. Our forecasts and warnings protect UK communities and infrastructure from severe weather and environmental hazards every day – they save lives and money. Our Climate Programme delivers evidence to underpin Government policy through the Met Office Hadley Centre. Our Mobile Meteorological Unit supports the Armed Forces around the world. We build capacity overseas in support of international development. All of this built on world-class environmental science.

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The Microbiology Society is a membership charity for scientists interested in microbes, their effects and their practical uses. It is one of the largest microbiology societies in Europe with a worldwide membership based in universities, industry, hospitals, research institutes and schools.

Our principal goal is to develop, expand and strengthen the networks available to our members so that they can generate new knowledge about microbes and ensure that it is shared with other communities. The impacts from this will drive us towards a world in which the science of microbiology provides maximum benefit to society.

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The National Physical Laboratory (NPL) is the United Kingdom's national measurement institute, an internationally respected and independent centre of excellence in research, development and knowledge transfer in measurement and materials science. For more than a century, NPL has developed and maintained the nation's primary measurement standards - the heart of an infrastructure designed to ensure accuracy, consistency and innovation in physical measurement.

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We challenge the way people think about the natural world – its past, present and future

We use our unique collection and unrivalled expertise to tackle the biggest challenges facing the world today.

We are leaders in the scientific understanding of the origin of our planet, life on it and can predict the impact of future change.

We study the diversity of life and the delicate balance of ecosystems to ensure the survival of our planet.

We help enable food security, eradicate disease and manage resource scarcity.

We inspire people to engage with science to solve major societal challenges.

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The University of Northampton is an institution committed to science education through initial teacher training, a STEM Ambassador network which works within the community and teaching and research to doctoral level. We are an Ashoka U 'Changemaker Campus' status university recognising our commitment to social innovation and entrepreneurship.

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With 43,000 students and campuses in Nottingham, China and Malaysia, The University of Nottingham is 'the nearest Britain has to a truly global university'. With more than 97 per cent of research at the University recognised internationally according to the Research Excellence Framework 2014, the University is ranked in the top 1% of the world's universities by the QS World University Rankings.

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The Nutrition Society is a not for profit, membership organisation which is dedicated to delivering its mission of advancing the scientific study of nutrition and its application to the maintenance of human and animal health. Highly regarded by the scientific community, the Society is one of the largest learned societies for nutrition in the world and anyone with a genuine interest in the science of human or animal nutrition can become a member.

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Physiology is the science of how molecules, cells and organs work in the body. Representing over 3500 life scientists, The Physiological Society supports scientific research through its grants schemes, conferences and its three open access journals.

The Society also supports the teaching of physiology in schools and universities, and works to promote an understanding of physiology amongst policy-makers and the general public.

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Prospect is an independent, thriving and forward-looking trade union with 117,000 members across the private and public sectors and a diverse range of occupations. We represent scientists, technologists and other professions in the civil service, research councils and private sector.

Prospect's collective voice champions the interests of the engineering and scientific community to key opinion-formers and policy makers. With negotiating rights with over 300 employers, we seek to secure a better life at work by putting members' pay, conditions and careers first.

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Opening fully in mid-2018, the Quadram Institute will be an interdisciplinary research centre capitalising on the academic excellence and clinical expertise of the Norwich Research Park. Its mission is to understand how food and the gut microbiota link to the promotion of health and preventing diet and age related diseases. The Quadram Institute brings together fundamental and translational science with a clinical research facility for human trials and one of Europe's largest gastrointestinal endoscopy units. This will synergise interactions between basic and clinical research, delivering a step change in the understanding of the role of food in health.

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As the UK's national academy for engineering, we bring together the most successful and talented engineers for a shared purpose: to advance and promote excellence in engineering. We have four strategic challenges: drive faster and more balanced economic growth; foster better education and skills; lead the profession; and promote engineering at the heart of society.

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RBG Kew is a centre of global scientific expertise in plant and fungal diversity, conservation, and sustainable use, housed in two world-class gardens. Our scientific vision is to document and understand global plant and fungal diversity and its uses, bringing authoritative expertise to bear on the critical challenges facing humanity today.

Kew's strategic priorities for science are:

1. To document and conduct research into global plant and fungal diversity and its uses for humanity.
2. To curate and provide data-rich evidence from Kew's unrivalled collections as a global asset for scientific research.
3. To disseminate our scientific knowledge of plants and fungi, maximising its impact in science, education, conservation policy and management.

These priorities enable us to curate, use, enhance, explore and share Kew's global resource, providing robust data and a strong evidence base for our UK and global stakeholders. Kew is a non-departmental government body with exempt charitable status, partially funded by Defra.

The Royal Institution
Science Lives Here

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The Royal Institution (Ri) has been at the forefront of public engagement with science for over 200 years and our purpose is to encourage people to think further about the wonders of science. We run public events and the famous CHRISTMAS LECTURES®, a national programme of Masterclasses for young people in mathematics, engineering and computer science, educational activities at the L'Oréal Young Scientist Centre and policy discussions with science students. And through the Ri Channel we share the stories behind cutting-edge science with people around the world.

THE ROYAL SOCIETY

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The Royal Society is the academy of science in the UK and the Commonwealth comprising 1400 outstanding individuals representing the sciences, engineering and medicine. The Society has played a part in some of the most fundamental, significant and life-changing discoveries in scientific history and Royal Society scientists continue to make outstanding contributions to science across the wide breadth of research areas. Through its Fellowship and permanent staff, it seeks to ensure that its contribution to shaping the future of science in the UK and beyond has a deep and enduring impact, supporting excellence in science and encouraging the development and use of science for the benefit of humanity.

Royal Society of Biology

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The Royal Society of Biology is a single unified voice, representing a diverse membership of individuals, learned societies and other organisations. We are committed to ensuring that we provide Government and other policy makers – including funders of biological education and research – with a distinct point of access to authoritative, independent, and evidence-based opinion, representative of the widest range of bioscience disciplines. Our vision is of a world that understands the true value of biology and how it can contribute to improving life for all.

ROYAL SOCIETY OF CHEMISTRY

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The Royal Society of Chemistry is the world's leading chemistry community, advancing excellence in the chemical sciences. With over 50,000 members and a knowledge business that spans the globe, we are the UK's professional body for chemical scientists; a not-for-profit organisation with 170 years of history and an international vision of the future. We promote, support and celebrate chemistry. We work to shape the future of the chemical sciences – for the benefit of science and humanity.

society for applied sfam microbiology

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*Sf*AM is a UK organization, serving microbiologists internationally. It works to advance, for the benefit of the public, the science of microbiology in its application to the environment, human and animal health, agriculture, and industry. With Wiley-Blackwell, *Sf*AM publishes five internationally acclaimed journals. Value for money and a modern, innovative and progressive outlook are its core principles. A friendly society, *Sf*AM values integrity, honesty, and respect, and seeks to promote excellence and professionalism and to inspire young microbiologists.

Society for Underwater Technology

SUT Society for Underwater Technology

Society for Underwater Technology
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The SUT is a multidisciplinary learned society that brings together individuals and organisations with a common interest in underwater technology, ocean science, and offshore/subsea engineering. The society was founded in 1966 and has members from over 40 countries, including engineers, scientists, other professionals and students working in these areas.

Society of Chemical Industry

SCI: where science meets business

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Established by Royal Charter in 1881, SCI is a unique multi-disciplinary community. Set up by a prominent group of forward thinking scientists, inventors and entrepreneurs, SCI continues to be a multi-science and industry network based around chemistry and related sciences. Our charitable objective is to promote links between science and industry for the benefit of society. Our passion is invention and creation.

We deliver our charitable objective by:

- Supporting the commercial application of science into industry
- Tackling global challenges across Agrifood, Energy, Environment, Health and Materials

Society of Cosmetic Scientists

SCS SOCIETY OF COSMETIC SCIENTISTS

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Advancing the science of cosmetics is the primary objective of the SCS. Cosmetic science covers a wide range of disciplines from organic and physical chemistry to biology and photo-biology, dermatology, microbiology, physical sciences and psychology.

Members are scientists and the SCS helps them progress their careers and the science of cosmetics ethically and responsibly. Services include publications, educational courses and scientific meetings.

Society of Maritime Industries

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The Society of Maritime Industries (SMI) is the voice of the UK's maritime engineering and business sector promoting and supporting companies which design, build, refit and modernise ships, and supply equipment and services for all types of commercial and naval ships, ports and terminals infrastructure, offshore oil and gas, maritime security and safety, marine science and technology, maritime autonomous systems and marine renewable energy.

UK INNOVATION & SCIENCE SEED FUND

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Website: https://ukinnovationscience seedfund.co.uk/

The **UK Innovation & Science Seed Fund** is a leading patient capital investor with more than £330 million private investment leveraged to date. The Fund works to build technology companies from the earliest stage by working closely with its partners led by STFC, BBSRC, NERC and Dstl, with the National Research and Innovation Campuses they support, and with entrepreneurial science-led teams. UK Innovation & Science Seed Fund is also closely aligned with the Catapults and InnovateUK, helping to commercialise key technological advances in industrial biotech, agricultural technology, healthcare, medicine, clean energy, materials, artificial intelligence, software and space.

Understanding ANIMAL RESEARCH

Contact: Chris Magee
Head of Policy and Media
Understanding Animal Research
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http://www.understandinganimalresearch.org.uk/

Understanding Animal Research is a not-for-profit organisation that explains why animals are used in medical, veterinary, environmental and other scientific research. We aim to achieve a broad understanding of the humane use of animals in medical, veterinary, scientific and environmental research in the UK. We work closely with policymakers to ensure regulation is effective and are a trusted source of information for the national and international media. We are funded by our members who include universities, professional societies, trade unions, industry and charities.

University of Essex

Contact: Dr Rob Singh
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E rjsingh@essex.ac.uk
W www.essex.ac.uk/business

Established in 1964, the University of Essex is ranked as one of the Top 20 universities in the Research Excellence Framework and is awarded Gold in the Teaching Excellence Framework. It is home to world-leading expertise in analytics and data science, with research peaks spanning the social sciences, sciences, and humanities. Pioneers of quantitative methods and artificial intelligence techniques, Essex is also in the UK top 10 for Knowledge Transfer Partnerships, and works with businesses to embed innovation into operations, through KTPs, knowledge exchange and contract research.

Universities Federation for Animal Welfare

UFAW Established 1926

Contact: Dr Robert Hubrecht OBE
Chief Executive and Scientific Director
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Email: ufaw@ufaw.org.uk
Website: www.ufaw.org.uk
Registered in England Charity No: 207996

UFAW, the international animal welfare science society, is an independent scientific and educational charity. It works to improve animal lives by:

- supporting animal welfare research
- educating and raising awareness of welfare issues in the UK and overseas
- producing the quarterly scientific journal Animal Welfare and other high-quality publications on animal care and welfare
- providing advice to government departments and other concerned bodies.

The Welding Institute

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The Welding Institute is the leading institution providing engineering solutions and knowledge transfer in all aspects of manufacturing, fabrication and whole-life integrity management.

Industrial membership provides access to innovative problem-solving from one of the world's foremost independent research and technology organisations.

Non-Corporate services include membership and registration, education, training and certification for internationally recognised professional development and personnel competence assurance.

TWI provides Members and stakeholders with authoritative and impartial expert advice, knowhow and safety assurance through engineering, materials and joining technologies.

SCIENCE DIARY

PARLIAMENTARY AND SCIENTIFIC COMMITTEE – A PROSPECTIVE ALL-PARTY PARLIAMENTARY GROUP

Tel: 020 7222 7085
Email: office@scienceinparliament.org.uk
www.scienceinparliament.org.uk
follow us on Twitter @ParlSciCom

Evening Discussion

Meetings at 5.30pm followed by dinner

- Monday 13th January: Smart Energy
- Monday 24th February: Noise
- Monday 30th March: Autonomous Vehicles

Tuesday 21st January at 12.30pm

Annual Lunch

Guest Speaker - Dame Jocelyn Bell Burnell DBE FRS
(postponed from 19th November)

ROYAL ACADEMY OF ENGINEERING

Details all events can be found at https://www.raeng.org.uk/events

ROYAL SOCIETY OF BIOLOGY

Details of events can be found on www.rsb.org/events

ROYAL SOCIETY

Details of all events can be found on the events calendar at events@royalsociety.org
For scientific meetings queries: scientific.meetings@royalsCociety.org

THE ROYAL INSTITUTION

Details of all events and booking information can be found at www.rigb.org/whats-on.

THE PHYSIOLOGICAL SOCIETY

Tuesday 28 January 2020, 6pm

Sport & Exercise Science in Wales

Welsh Assembly, Cardiff

Sport and Exercise Science (SES) is a hugely important part of the Welsh economy, with Sport Wales estimating that sport-related activity generates £1.2 billion in expenditure.

Physiological understanding is the foundation of advancements in sport training, performance, and health. Just as athletes and coaches seek to maximise performance and reduce injury, SES graduates are involved in disciplines as diverse as health education, research into the impact of exercise on physical and mental health, disease prevention, and post-operative outcomes.

Our event in the Welsh Assembly on 28 January will hear from politicians, researchers and policy makers about the vital role of SES to keeping Wales healthy and growing the economy.

This event builds on the success of our UK report, which can be read here: www.physoc.org/sportscience

To register to attend email amackenzie@physoc.org

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Science and the New Parliament

On behalf of the science and engineering community and all the scientific organisations listed below
we welcome all Members of the new Parliament
and we stand ready to offer advice and assistance on the many issues with which you will be dealing.

BRITISH PHARMACOLOGICAL SOCIETY

ROYAL SOCIETY OF CHEMISTRY

Royal Society of Biology

The Council for the Mathematical Sciences

SEB
SOCIETY FOR EXPERIMENTAL BIOLOGY

BIOCHEMICAL SOCIETY

The Geological Society

British Society for immunology

100 YEARS the geneticssociety 1919 - 2019

RSE The Royal Society of Edinburgh
KNOWLEDGE MADE USEFUL

BRITISH ECOLOGICAL SOCIETY

The Physiological Society

IOP Institute of Physics

THE NUTRITION SOCIETY Advancing Nutritional Science

sfam society for applied microbiology